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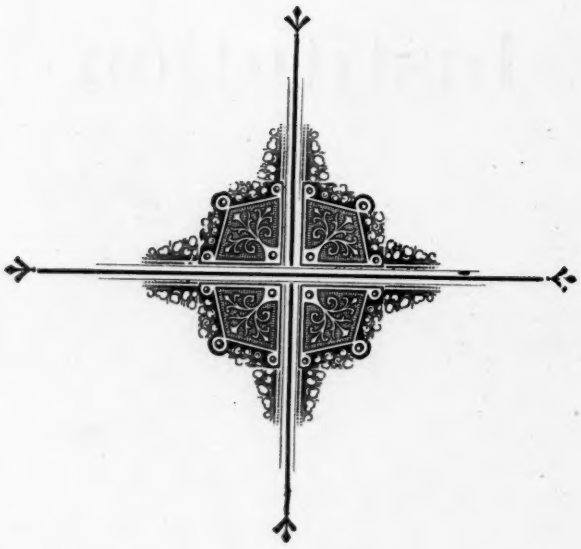

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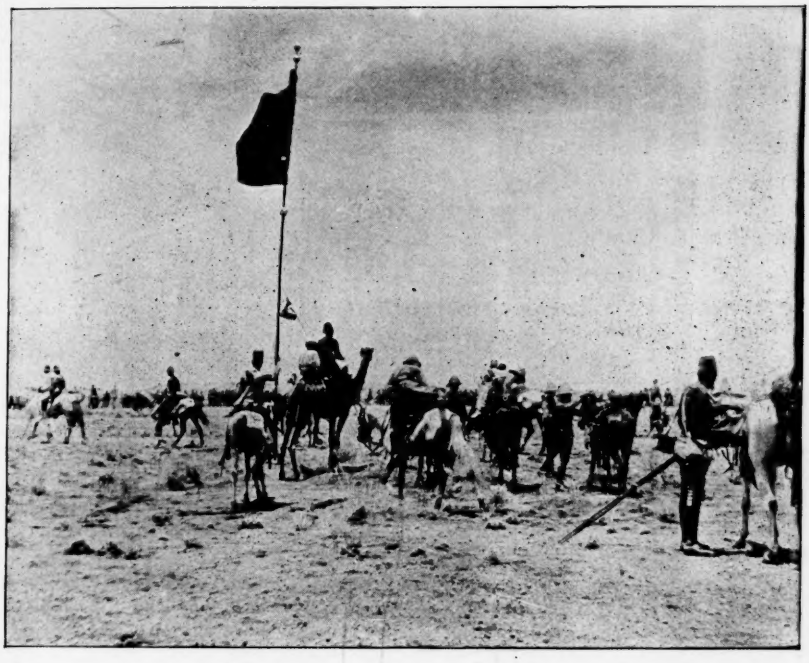

The Khalifa's Great Black Flag, carried behind the Sirdar after its capture at the end of the Battle of Khartum. The Sirdar is riding on a light grey on the extreme left.

Part of a breach made in the great wall of Omdurman by the 37th (Howitzer) Field Battery, R.A.

From Photographs taken on the spot by Lieut. Hon. E. D. Loch, D.S.O., Grenadier Guards.

On Tuesday, 10th January, 1899, at 3.30 p.m., Captain S. M. Eardley-Wilmot, R.N., will deliver a Lecture suited to a Young Audience, on

THE NAVY DURING THE REIGN OF QUEEN VICTORIA.

On Monday, 16th January, 1899, at 3.30 p.m., Colonel E. J. Browell, late R.A., will also deliver a Lecture for a Young Audience, entitled :—

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Both Lectures will be illustrated by Lantern Slides.

THE JOURNAL
OF THE
ROYAL UNITED SERVICE INSTITUTION.

VOL. XLII. DECEMBER, 1898. No. 250.

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MANŒUVRES IN FRANCE OF TWO DIVISIONS OF CAVALRY AND OF AN ARMY CORPS IN SEPTEMBER, 1897,

UNDER THE DIRECTION OF GENERAL DE NÉGRIER.

By Major-General the Hon. R. A. J. TALBOT, C.B., Commanding the Cavalry Brigade, Aldershot.

Thursday, June 30th, at 4 p.m.

General H.R.H. the Duke of CONNAUGHT AND STRATHEARN, K.G., K.T., K.P., etc., Commanding Aldershot District, in the Chair.

INTRODUCTORY.

THE object I have in reading the following paper is to draw attention to the opinion as to the value of cavalry at the present day held by one of the foremost generals in France, one of the few who has commanded an army in the field. He is now an inspector of several army corps which, in the event of war, would be formed into an army which he would command. He very possibly will, before long, be Commander-in-Chief of the French Army, which, on mobilisation, may be counted by millions.

General de Négrier is no biassed witness, no hare-brained cavalry enthusiast, having always served in the infantry. I hope, therefore, that my comrades of the Staff, and those who serve, or who have served, in the arm which the French call, and which I acknowledge to be, the queen of battles, will attach some value to the opinions of this distinguished officer. The opinions are calculated to encourage cavalry soldiers by showing the importance of cavalry on the battle-field. In Germany these remarks would not be called for, neither in Russia, still less in Austria, for in those countries the action of cavalry is fully appreciated; but in France, as in England, it has been, especially since the last war, the fashion to depreciate the arm, and undervalue it in action.

I have endeavoured to translate literally, and preserve the freshness and force, and perhaps what would be called in England the Gallicisms or slight exaggerations in the tone of the French original.

There is not, I regret to say, a narrative of each day's work, but only the general's observations upon a deduction from the incidents of the manœuvres. This makes the remarks somewhat difficult to follow, and less instructive than if we had the narrative; but I hope, notwithstanding, that the paper may be considered of sufficient interest to have warranted me in reading it at the Royal United Service Institution. I of course do not necessarily adopt or accept all that is put forward, or consider myself in any way responsible for what I am about to read.

PRELIMINARY OBSERVATIONS.

In September, 1897, two divisions of cavalry, in concert with an army corps (the VIIth) executed manœuvres of an altogether special character under the direction of General de Négrier.

The general-director had principally in view a wish to alter, in some degree, the opinion which infantry and cavalry have mutually of each other.

To the infantry the director would say:—"Have all confidence in your weapon; your rifles are excellent; but do not deceive yourself in thinking that any firearm existing has the power to keep off from you with certainty raging attacks of cavalry. However perfect your rifles, however great the modern improvements, do not neglect or despise cavalry, which is the arm of shock and of overwhelming force. You may some day suffer from it. Learn rather, it would be wiser how to defend yourselves against cavalry when it is unloosed."

To the cavalry the director would say:—"You have been disturbed by theories as to the formidable power of the firearms now in use. Let scientific people talk, while you trust in yourselves. Take stock of your own strength. It is not the rifles, so accurate when fired at the butts, which you have to overthrow, but the impressionable men who carry them, the men who have not changed since the days of Adam. You are to-day what you were yesterday and will be to-morrow—the arm of shock and of overwhelming tactics, the arm of audacity and of inspiration, as long as you have chiefs who know how to make use of fortune and opportunity.

"There are those who have wished to reduce you to a mere service of intelligence and information. By the way, even as regards that service, no cavalry which is over-prudent, methodical, and scientific, and believes in the superiority of a rifle over a horse, will ever get good information; on the contrary, the best reconnoitring cavalry will be one which is dashing and bold, sceptical of mathematical calculations, believing only in the immense moral force it has within it. A cavalry whose men dream of the naked sword and of the charge, a cavalry which is always in quest of adventure, and always on the look-out for favourable occasions for indulging a passion for combat."

To infantry and cavalry together the director would say:—"Know each other a little more. Do not play each for your own hand, without attending to your neighbour. Learn that the great art of working together is one of the secrets of victory."

Such were the ideas of the general-director; but knowing that words have little effect unless borne out by practical illustration, he proposed to exemplify them during the manœuvres, making clear and explaining the various situations at the conference on each day.

ARRANGEMENT OF MANŒUVRES.

First Period.—Concentration while manœuvring.

Second Period (*three days*).—Where two divisions of cavalry supported by a brigade of infantry are opposed to an army corps.

Third Period (*three days*).—The practice of certain instances in cavalry tactics. The units composing the two sides changing each day.

CONCENTRATION WHILE MANŒUVRING.

The day on which the concentration terminated, a manœuvre of cavalry *v.* cavalry took place.

The station of Gray being the place where numerous troops detrained, the 1st Division of Cavalry, supported by a few rifles, was entrusted with the task of pushing forward to cover the disembarkation. The enemy's cavalry division (the 2nd), to which was added a brigade, bringing up the force to eight regiments of cavalry, was ordered to move rapidly and endeavour to destroy this same railway station.

The general idea giving the situation of the two forces necessitated that the 1st Division should cross the river Saône.

The observations of the general-director bore upon the following points:—

a. The importance of defiles or narrow passages on the field of operations of two opposing forces of cavalry.

A division of cavalry which has to carry out any mission obliging it to repair to any particular spot will always have one or more narrow passages to pass. For such a considerable force (which on a single road extends over more than 6 kilometres), the passage of a defile, even when covered by its artillery, is a critical situation which cannot last less than half an hour, generally much more.

The art for this cavalry will consist in passing where it is not expected, or, if the place of passage is known, then at an unexpected moment. In short, to make use of its mobility in deceiving the enemy, either as to the spot or as to the time of passing.

The art for the opposing cavalry will consist in being so well informed that it can arrive unexpectedly and throw all its force upon the enemy while engaged in this critical operation, and attack either the head or the rear, on one bank or the other (for in this case it is a river), little matters—all is in favour of the attacking force, and it ought to win. Nevertheless, if the attack can be delivered in the rear of the column the success will probably be more complete and decisive.

The attacking force has the *beau rôle*, which, in theory, seems simple, in execution it is less so.

In order that information as to the spot and hour of the crossing should arrive in useful time it is necessary that there should be exceptionally good messengers, that is to say, selected officers mounted on

thoroughbred horses in high condition. To make use of the information regiments must gallop and manœuvre galloping, because it is only at that pace that the fleeting opportunity can be seized. It must be remembered that moving across a strange country, with all its unknown obstacles and difficulties, is quite another thing to crossing country round our standing camps.

The general discussing this most important question of obtaining and transmitting information gave some useful advice.

b. Service of intelligence. Necessity to perfect it by means of officers attached to the general in command and mounted on very well-bred horses.

When altogether ignorant of the whereabouts of an enemy and all is unknown, it is well that reconnaissance should be conducted by experienced officers, for under the above conditions the nose and instinct of a blood-hound are required to avoid wandering in a circle, or else uselessly into space. When the existence and direction of the enemy's column have been discovered, junior or even sub-officers can be trusted to keep touch and watch the line of advance.

The more experienced officers will be reserved for the still more difficult and delicate mission of hovering on the enemy's flanks, and ascertaining the composition and depth of the columns.

Lastly, and most important, the general will have at his disposal, besides his own gallopers, selected officers on well-bred horses always ready at the first sign to go forward and bring back rapidly clear answers to clear questions such as "Is such a point still clear? On which bank and from what point to what point is the enemy moving at this moment? It has been asserted that between such and such points no ford is practicable. Is this true? Perhaps the river is being crossed elsewhere; go and see."

These officers returning, almost before they have started, clear up certain points which the ordinary service of information has left vague or contradictory. By the precision and lateness of the information they bring, a clear light is thrown upon the situation, which enables the general to make his decision as to how he can best take advantage of his opportunities.

FIRST PERIOD OF THREE DAYS, 8TH, 9TH & 10TH SEPTEMBER.

GENERAL IDEA.

Two Divisions of Cavalry, supported by a Brigade of Infantry, are opposed to an Army Corps (the VIIth) on the march upon Gray.

There is no doubt that manœuvres of this description will frequently take place in future wars; many an occasion will arise for hurling masses of cavalry against armies or army corps on the march whether before or after battle.

It is necessary, therefore, that cavalry should learn this *rôle*, which is so characteristic of the arm, namely, of hovering round and threatening a strong but inagile enemy while always itself untouchable.

It should be on the look-out to pounce upon the enemy, and in situations rendered difficult, perhaps dangerous, by the features of the ground to take advantage of any mistakes it may make.

It is necessary also that our infantry should be well aware, so that they may prepare themselves, what a strain upon the nerves it is to move under the constant menace of a sudden attack, to march with the feeling of being shadowed by a fierce and tenacious enemy who is everywhere and yet nowhere; who sees you, but whom you cannot see; who can choose his own moment to attack you, and whom you cannot attack because it is intangible. Infantry well instructed and prepared for such emotions, taught not to fear cavalry, but at the same time to reckon with it, will know how to meet its attacks, and to protect itself by a judicious occupation of such points of vantage to the front and to the flanks as may be necessary. It can thus continue its movement, if not without delay and some loss, at least without disorder and disaster.

But infantry too confident in its strength, disdainful of cavalry charges which it considers belong to another age, may well, in the course of a march, little by little, lose its coolness (*sang-froid*), and become pervaded by that terrible panic which leaves it defenceless under the sabres of the troopers and the feet of their horses.

The general-director has devoted three days to the exercise of an army corps on the march, surrounded by a cloud of hostile cavalry.

His remarks bear upon the following points:—

A.—TACTICS OF CAVALRY ENTRUSTED WITH THE TASK OF INTERFERING WITH THE MARCH OF AN ARMY OR AN ARMY CORPS.

A body of cavalry with artillery, which has received orders as above, has generally a tendency only to make use of its guns. This is insufficient.

a. Attack with the gun and with the horse.

When the batteries suddenly crown a crest and open fire upon the enemy's columns, the cavalry should not be satisfied in watching the cannonade. It should, during the deployment of the infantry columns, move briskly on to the flanks of the deployment with the hope of charging them. It has many chances of finding a good opportunity, because the infantry is fully occupied by the shells which peremptorily force it to develop its front, and cannot always attend to what happens on the flank. In the nerve-trying march against the guns, which are raining shells upon it, and which are too distant to reply to, the infantry may, at a certain moment, show some hesitation, some unsteadiness. It is at that moment that the squadron should arrive on the flank.

Charges will come off and get home if the gallop of approach does not exceed 400 or 500 yards, and it is seldom that the ground does not lend itself to conceal skilfully-led cavalry from its objective up to that distance.

Meanwhile the enemy's artillery pushes forward to the support of the infantry, probably to one flank whence it can easily crush the fire of the flying (horse artillery) batteries. Let the cavalry cock its ears! It

is, perhaps, the moment for a dash. It must be without hesitation, with full confidence in the result, if these batteries should be momentarily separated from a sufficient support.

b. Attack by gun and carbine.

Sometimes charges are very difficult, and in enclosed country deployments may be impossible. In that case cavalry must remember that it has besides horses, sabres, and cannon, an efficient firearm.

The general-director here laid down a principle which, owing to its novelty, appeared to surprise his audience. Cavalry, he said, should as a rule fire with high sights, infantry with low ones. The lowest normal range for cavalry should be 600 to 700 yards, and this should be the furthest normal range for infantry.

In fact, the French infantry should know that its real power does not lie in its rifle, but in its power of marching. *In pedite robur.* If when against hostile infantry it has the courage and the discipline not to open fire until 600 yards, it can at that distance smash by its crushing fire any resistance, and can continue that advance forward which leads to victory.

Cavalry, on the other hand, does not open fire with the intention of assault—it skirmishes and delays a march, or annoys a flank. It is all ready to skeddadle when the enemy seriously turns upon it. It would be a great fault if in playing this subsidiary game it exposed itself to the heavy losses which would inevitably ensue should the enemy's rifles come within 600 yards.

Cavalry should, therefore, be accustomed to fire between 1,500 (and even further) and 800 yards. Then in enclosed country where it cannot deploy to attack mounted, it may be able at long ranges to send bullets into the flanks of the opposing columns. It is likely that many bullets will not hit their mark, but a sufficient proportion will arrive to try the nerves of the infantry, and to necessitate a detachment being sent out to drive off these annoyers. During the passage over the space of 800 yards (namely, from 1,500 to 700) the dismounted cavalry can meet this detachment with a sustained fire; after that distance the enemy's rifles will become too dangerous, and the cavalry will disappear to suddenly re-appear further on, making their carbines speak from another point, unless perhaps an opportunity arises of sweeping up the enemy's detachment before it has rejoined the column.

c. The mounted attack unaided by gun or carbine.

While on some ground dismounted combat is only possible, there are others so favourable for surprise that they seem to demand the mounted combat unaided by other arms. Such are certain table-lands which are everywhere practicable for cavalry, but so undulating that the eye cannot follow galloping horsemen, who appear upon a ridge to disappear into a hollow.

If in such a country a body of cavalry comes upon a column, it must not give the alarm with the loud noise of its field pieces. It is the occasion on which to dash forward in silence, without the loss of a

second. The batteries will be of use later, for after the charge the shells will prolong the panic and prevent rallying.

d. Attack by guns alone.

Cavalry opposed to the advance of an army or army corps will never let its artillery work alone, except when impossible to second its efforts by horses or by carbines, which, by the way, cannot be ascertained without trying. These attempts will at least have the advantage of being disturbing demonstrations for infantry during the passage of the critical 1,000 yards (2,500 to 1,500) when it is receiving shells, and cannot reply with bullets.

e. The division of cavalry broken up into brigades when the inferiority of the opposing cavalry admits of this being done.

Attacks whether by guns, by cavalry by itself, by guns and cavalry, or by guns and dismounted fire, will produce an effect upon a column in proportion to the number of different points attacked. The general lays down that always to cling to the concentration of troops is to work in a groove, and all grooves are bad. What is the object of concentration? To be always stronger than the enemy. Well, here are two divisions of cavalry which know for certain that the army corps which they are harassing has only one brigade of cavalry. It is only rational to break up the divisions into brigades. Each of these brigades will always be stronger than the opposing brigade, which has necessarily detached some men for duties with the infantry. Each of these brigades with a battery attached should be hurled upon a different point of the infantry column. The general of each cavalry division would do well to keep with him a brigade in reserve—a light brigade, for instance—which could rapidly be sent wherever occasion required.

It is unfortunate, says the general-director, that the third battery has been taken from the cavalry divisions. When the enemy's cavalry has either been beaten or is not on the spot, many an occasion will arise for brigades to act independently, and for them to do so most effectively they require their battery. Not only should the third battery be restored to each division, but each corps brigade should have its battery as part of its organisation.

B.—THE TACTICS OF HORSE ARTILLERY BATTERIES.

It will be said in criticism of the tactics suggested in the last section that the breaking up of artillery is contrary to principles universally admitted to be correct, viz., the concentration of artillery fire.

A little consideration will show that horse batteries should not be used like field batteries. It is not their *rôle*, like the latter, to remain as it were fixed to the position taken up until they have overpowered and crushed all that opposes and stands up against them. Horse artillery has special tactics because of its mobility. Concentration is not always a necessity or the means by which horse artillery can be most effectively used.

Perhaps on an occasion horse artillery will open fire at long ranges (2,500 to 3,000 yards) upon infantry on the march, forcing it to deploy in

order to advance upon the guns. Then when the infantry has with difficulty arrived at a distance (1,500 yards) when its volleys may be effective, the batteries will disappear. On another occasion horse artillery may cause the enemy's field batteries to come into action, and when they open fire the lighter batteries take themselves off.

Again, it may have opportunities of throwing confusion and disorder among cavalry halted and massed.

Another day it may disturb and harass troops in cantonments.

During a battle while the heavier batteries are shelling the front of a position the light horse artillery batteries may co-operate on a flank. Like squadrons of cavalry, horse artillery must be intangible, and specially work upon the *moral* of the adversary, which never knows from which side the blows will fall, and when the latter turns furiously in the direction from which they have come finds that the guns have vanished.

Officers of horse artillery should, therefore, be horse soldiers in the fullest sense of the term, which will not prevent them still being gunners in directing carefully-aimed fire. Thus, a battery which gallops to head a column must not, owing perhaps to the exciting effects of the gallop, fire precipitately, but with calmness and deliberation. Precipitation may perhaps be excused in a fight between cavalry and cavalry where moral effect is of more importance than accuracy of aim, and accuracy of aim with a galloping target is not easily attainable. But against infantry debouching from a defile against heavier guns it is the accuracy of fire and not the rapidity which will produce the greatest effect.

C.—TACTICS OF INFANTRY ON THE MARCH HARASSED BY CAVALRY AND ARTILLERY.

What has been said with reference to the tactics of cavalry and horse artillery shows how infantry should act when harassed by those arms. As infantry is less powerful when on the march, or when taken by surprise, it is necessary that it should be protected by halted detachments well on their guard.

This *rôle* is comparatively easy for advanced guards, but much more difficult for flank guards. The latter, to perfectly protect the column which they cover from all fear and possibility of surprise, should be established at points sufficiently distant. These detached bodies should be strong and composed of the three arms, for without cavalry they will be surprised, without artillery they will be destroyed from a distance, and may be obliged to give up positions which protect the movements of the main body.

Flank guards composed as above described will be a cause of great fatigue to the infantry which forms part of them, and their employment will necessitate slow movement for the main body, but they constitute the only means of ensuring for it an uninterrupted march. Flank guards are also of great service, as was shown most conclusively by the general commanding the VIIth Corps during the 10th of September, in covering the movement of infantry while engaged in changing from one line of march to another.

SECOND PERIOD OF THREE DAYS, FROM 12TH TO 15TH SEPTEMBER.

STUDY OF CERTAIN INSTANCES IN CAVALRY TACTICS. THE COMPOSITION OF THE TROOPS CHANGES EACH DAY.

During this period the general officers commanding the army corps and the two divisions gave their respective commands to cavalry generals.

In the account of the work done in the preceding period nothing has been said of the support given to a corps of cavalry by a brigade of infantry. This is always a very important matter, but the omission was intentional for in two of the three days of the period about to be discussed, the manner in which the two arms can work together and help each other will be brought out.

General Idea for the Manœuvres of the 12th September.

The opposing sides each consist of a division of cavalry and a division of infantry. One side detached from Dijon has pushed across the river Vengeanne where reinforcements should reach it. Meanwhile it is attacked by the opposing force which is the advanced guard of a large body. Retreat is necessary.

a. Support of cavalry by infantry.

Until the last moment the cavalry division of the force which has to retire can remain on the far side of the river doing the double duty of containing the adverse cavalry and of working upon the flank of the assailants in order to delay them. At last, under the nose of the enemy's cavalry, it crosses the river, strongly held by its infantry in safety.

b. Support of infantry by cavalry.

The passage of the river is forced, the cavalry of the advancing side crosses the river below the point where the passage was forced to throw itself on the line of retreat of the enemy, but it runs against the cavalry of the retiring side, which thus protects its infantry and repays the service it received just now from the latter.

The general-director now makes two criticisms of importance, one to the cavalry, the other to the infantry.

To the cavalry he pointed out that the events of the day proved how important were some details already alluded to for a proper execution of the intelligence service. For instance, the cavalry of the retreating side had established posts at the passages of the river, and yet the opposing cavalry arrived upon the retiring cavalry unexpectedly. Had the posts been carried? Had the messengers lost themselves or been taken? It matters little, the naked fact remains such as will occur in war, that the enemy's cavalry crossed where it was not perceived. If a couple of officers well mounted had galloped to where the river was passable above and below where it was guarded, they would have brought the information "Nothing to fear above, but below the enemy is preparing to cross."

To the infantry the general-director said that in retirements counter-attacks were absolutely necessary. The passage of the river by the enemy was sooner or later inevitable, but counter-strokes should have

been prepared. Troops should have been concealed near the bridges which were held when the bridges are forced ; these troops should have emptied their magazines upon an enemy in disorder, and then, with the point of the bayonet, driven him into the water. By such means an hour or two respite would have been gained for the retiring force.

Manœuvre of September 13th.

Extrication of infantry from an engagement by the intervention of its cavalry.

A body of infantry far from reinforcements finds itself opposed by a force which is constantly being reinforced. It wishes to break away without disaster, and for this it is necessary to check the enemy for a moment. It calls upon its cavalry for aid.

It is an occasion upon which to take advantage of the facility with which small bodies of cavalry can conceal themselves in the folds of the ground. Regiments, wings, and squadrons were sent, not to place themselves under the orders of commanders of troops engaged, but to act entirely on their own initiative, with complete liberty of action, their only instructions being to attack and use their swords if they saw any possibilities. It answered completely. Although the assailing infantry were aware that in the course of the day attacks by cavalry would be made, it was nevertheless almost everywhere taken by surprise. Almost everywhere swarms of horsemen appeared and disappeared and suddenly re-appeared at very rapid pace. Almost everywhere one felt that the charges would have got home; they would have hustled and perhaps even caused a complete panic among the infantry. The losses of men and horses would not have been excessive, for the horsemen would have taken care to clear off before the enemy recovered its presence of mind. The object would have been attained, for the retiring infantry would have gained the time and the ground necessary to prepare for an orderly retreat.

The events of this day proved to officers of every arm a truth apparent and tangible, a precept which cannot be too loudly asserted and insisted upon:—CAVALRY CAN AND SHOULD CHARGE IN THE PRESENT DAY AS IT WAS USED TO CHARGE IN THE DAYS OF THE FIRST EMPIRE.

When a charge fails, and it is possible to judge even at manœuvres whether it fails or succeeds, it is never because cavalry has ceased to be the arm of assault and of riding down as of old, but it is always due to one of the following causes.

Reasons of unsuccessful charges.

1. The cavalry leader receives an order by an orderly officer to charge immediately. As it is almost impossible that at the exact moment when he receives this order, a favourable opportunity for charging should present itself. This order during manœuvres seems rather ridiculous, in war it means an order courting disaster and death.

The French cavalry in 1870 gave some splendid instances of

obedience to such orders, which were, in fact, rides to destruction and death.

2. The cavalry leader has full initiative allowed to him. A condition so vitally important that in future we will suppose it always to be given. But this officer has not the soul of a cavalry leader. A man of intelligence and brains, he would have commanded in another branch with distinction; but he has not the quickness of mind, the intuitive eye to a country, the power of instantaneous decision—gifts which may be developed but cannot be created.

An officer of this description has his head full of a plan to meet preconceived circumstances; the actual circumstances are altogether different. He has never had, never will have, the inspiration to act on the spur of the moment, and without it cavalry cannot be handled effectively.

3. The cavalry leader has the soul of the cavalry soldier but no longer the body. He does not ride often enough and is not in condition to gallop fast across country. His horse more accustomed to trot along a road, when asked to gallop shows clumsiness and disinclination. Both horse and rider become blown. The gallop which in those used to quick paces only exhilarates and excites the best faculties, in those out of practice causes blood to the head. This sort of man with his head on a pillow would be able to meet every eventuality, but on his horse he will be able to deal with none.

4. The leader may be everything that is to be desired, but the troops are not real cavalry. Whether this is due to the horses being underbred or insufficiently trained or to the bad riding of the men, the troops as soon as it is necessary to gallop fast over varying and unknown ground are no longer in hand. They cannot with calmness and rapidity resume a state of order from one of disorder. In a word, the troops only can do what they have been taught, that is to work over a flat ground at slow paces.

With mounted troops which are not real cavalry the most perfect cavalry leader may not be able to do good work. History does, indeed, give us some examples of recruits even performing prodigies, like those of 1814 who won the battle of Montereau, rolling all over their horses and clinging to their manes, while in their headlong descent they came down upon the bridge which was to be taken. But it is wise not to count upon accidental exceptions such as that; in truth you cannot expect good music from a musician, however good he may be, with bad instruments to play upon.

5. The cavalry leader may have all the aptitude and skill desirable, but having worked almost exclusively at manœuvres with his own arm, and having rarely acted against the other arms, he forms of their power, especially of infantry, an exaggerated idea. He does not realise how easy it is to approach them unperceived, he has no eye or skill in knowing when he may throw his cavalry upon them almost with certainty.

If his troops start from too far, the precious first seconds are perhaps lost in deployments according to the drill-book, which are too slow and

often useless. The formation little matters when men on foot are swooped upon, provided that the swoop happens at the moment of surprise while the brain is paralysed and the respiration cut short by the sudden danger which bursts upon them.

The intention of the general-director during these manœuvres was to work against this last source of weakness, namely, want of knowledge of other arms. Under his impulsion the cavalry has been encouraged to attack, and its efforts looked upon with a friendly eye. Faults have been made, that is incontestable, but lessons have been learnt which will not be forgotten. Is not this the object of all manœuvres? The infantry has also learnt something from these exercises, and it was apparent how necessary it is to keep cool when charged by cavalry, and also how necessary to learn how to act in concert with that arm.

A common tendency is for infantry to halt and watch the spectacle of squadrons charging, instead of taking advantage of the momentary respite to push on. Again, when the infantry sees its horse soldiers falling back in disorder often it is forgotten that they are followed up, and that its duty is to quickly seize positions from which the pursuers in loose formation can be fired upon.

These are faults which will disappear when infantry and cavalry, more accustomed to manœuvre together, have learnt to know and mutually to help each other.

General Idea for the Manœuvres of 14th September.

The Pursuit.

An army is retreating in three columns, covered by a strong rear guard, with orders to hold the enemy's cavalry, which is numerous.

On this day almost all the cavalry regiments have been given to the pursuing side, and the usual divisional organisation has not been adhered to.

a. Dispositions made by the pursuing side.

All the Cuirassier regiments (four in number) are united under one command. The orders are to hang on to the skirts of the enemy's rear guard and to sweep away any cavalry which tried to interpose itself between it and the rear guard. The Dragoons, Chasseurs, and Hussars, less powerful but more mobile, are employed to act on the wings of the retreating force, which will give opportunities of attacking the rear guard in front and in flank while the Cuirassiers menace the rear. Light regiments well mounted should not be held in leash, but their speed and dash should be utilised.

This re-partition of the different classes of cavalry, and when each is made use of according to its particular aptitude, is according to Napoleonic traditions. During the First Empire each army had its heavy and light cavalry increased or diminished according to the task which lay before it.

It is a sound principle that the arm of opportunity should be grouped according to circumstances.

The manœuvres of this day gave rise to numerous cavalry attacks, some of which fully succeeded, others less well.

The general had previously observed that when infantry cannot be surprised it must be shaken by artillery fire, and then its steadiness and coolness worn out and worried by troops in open order or in small bodies.

If these are followed (say at 400 or 500 metres) by dense and converging bodies, the enemy's infantry, having already lost some of its moral strength, will see itself threatened by terrible danger from different quarters and will be only capable of delivering an ill-aimed and harmless fire.

b. Dispositions of the retreating force.

The three groups covering the three retiring columns had each its own commander reporting directly to the general commanding the whole rear guard. The general kept with him a light cavalry regiment and a horse artillery battery, which he could rapidly launch to the aid of any portion of his rear guard.

The three sub-divisions of the rear guard should move with their heads more or less in line so that the enemy should not cut off one from another. They should also march rapidly so as not to lose touch with the troops whose retreat they cover. These conditions are essential but somewhat incompatible, and the incompatibility is a trump card in the game of an energetic pursuer.

The last conference. Cavalry charging in great masses.

This is the last day of the manœuvres. The general-director in his final conference mentions his satisfaction at the keenness and energy of all taking part. Then, addressing directly the cavalry officers, he speaks once more of the cavalry attack. "Let the charge against infantry be in your minds, not imbued with ideas of sacrifice, but with ideas of victory. It is the fashion to say because there were no successful charges in 1870 there will never be in the future; but at Mosborun Cuirassiers were launched against barricaded villages; at Sedan cavalry were hurled up a long glacis of fire against infantry quite fresh, unshaken, and not surprised. If a man jumps from an attic and breaks himself in pieces, does one say that he cannot jump? It is to be hoped that in the future wars our cavalry will not be used as it was in 1870.

In the great battles of the future, which will last two or three days, on fronts perhaps of 30 or 40 miles, with half a million or more combatants on either side, there will arrive the moment when the masses of impressionable men can no longer bear the extreme tension of their nerves, and have no longer any moral strength to resist a panic. What arm is so adapted to cause that panic as cavalry? When the commander-in-chief thinks that the psychological moment approaches, he ascertains what cavalry he can lay hold off—six, eight, or ten thousand horses.

He says to the cavalry general:—"The situation has arrived at the last degree of tension; the hour approaches when the slightest thing may cause victory or defeat. Take all your forces, rove round, search

and examine; there is a weak point somewhere; find it, and hurl yourself at it; your hour has come."

The cavalry general starts, and his mass of squadrons follow him, at a distance, from shelter to shelter. Numerous reconnoitring officers race off on their well-bred horses, and report rapidly what impressions and information they can collect, which are not always favourable. In one place the ground is impossible; in another the enemy is not shaken, and is on his guard, etc. Suddenly guided by an officer, who had come up greatly animated, the general gallops to a point of observation.

Yes! It is the place and moment. "FORWARD!"

The regiments leave their last shelter, they pass by supple and simple movements at a sharp trot the various obstructions which are inevitable in rear of troops in action. At last the friendly lines have been traversed, and they begin to gallop. At their actual gallop through infantry, artillery, across every obstacle, the cavalry rage on until all is passed, and there is no more enemy left to charge.

Ten thousand horsemen had started, and five thousand arrived. But the breach had been pierced, the desired effect is produced, panic seizes the enemy and spreads like a conflagration, victory is at hand, one last effort of the other arms and it is won.

"General," said a colonel of Hussars, in bidding adieu, "the confidence and belief in our arm had, during recent years, been taken from us, you have found it and restored it to us."

CONCLUSION.

Modifications it is desirable to introduce in the Cavalry Regulations.

It remains to deduce from these manœuvres certain lessons for the instruction of cavalry. The regulations have a very great influence upon the opinion and upon the spirit of an arm. In the regulations it is admitted that they are not finite, and are subject to alteration, which implies that they require revising as soon as they are behind the spirit of the times. Has not the moment come to revise and re-write the regulations of 1882, and to introduce in some form or another the following ideas?

1. A more distinct affirmative that cavalry is not only made to fight opposing cavalry and to obtain information, but also to fight the other arms, and to contribute to victory by charging the enemy.

2. A more comprehensive description of the various *rôles* in which cavalry may be employed in the different phases of a campaign contributing by combat to the efforts of other arms. Tactical lessons and rules in combat during such operations as have been described.

3. Suppression of normal dispositions and of the invariable attack in three lines. It is out of date.

Rigid rules have little by little disappeared from our regulations for the movement of small units, because it has been recognised that they had bad effect. It is the same thing with large units. At the present time regiments in a brigade, when the enemy's cavalry is approaching, are occupied in thinking whether they belong to the first line or to the second line on the right or to the third line on the left, instead of

watching what obstacle the enemy may meet with, what false movement it may make, and thus perhaps lose a good opportunity of throwing themselves upon it. Normal formations clip the wings of those with individual genius, and do not encourage the development of individuality in those without it.

4. Improvements in field movements: The present regulations are such an advance upon former ones that the question of evolutions may be considered as definitely settled; but that is not so. Deployments can and should be made more simple and more rapid. The manner in which troops may follow their leader, and in which that leader attains his objective, can and should be improved.

5. A more detailed and complete instruction in the use of the sword. Our soldiers bound to their officers are perfect for the actual shock, but in the *mêlée* which follows they should be more skilful and have more confidence in the use of their swords.

6. Musketry instruction: The men should be constantly used to fire at long distances. This necessitates practice in judging long distances and extended rifle ranges.

7. Each brigade of cavalry, whether divisional or corps, should have a battery of light galloping artillery attached to it.

8. The brigade thus completed constitutes preferably to the division the type of the large unit of cavalry, provided always that the regiments of which it is composed (three better than two) are of the same subdivision of the arm. In short, to maintain through all the phases of a campaign divisions each composed of brigades of Cuirassiers, Dragoons, and Hussars should be a rule as stereotyped as the one which now before the combat disposes the force in three lines.

Numerous are the instances, as on the day of these manœuvres devoted to the pursuit, when it would be well to separate the heavy cavalry from the light. For Cuirassiers exhaust themselves in trying to keep up with Hussars. The latter at the same time feel held back, not being able to take their flight they are kept back until the moment of the encounter to make frontal deployments where they would be crushed. Light cavalry to be victorious should depend upon its legs: it should dance round until a blunder is made, of which it takes advantage to burst upon its adversary.

The brigades of Light Horse, the brigades of Dragoons, the brigades of Cuirassiers should be grouped separately as in the days of the First Empire. Let not these groupings have an unchangeable composition; on the contrary, they should be modified according to the exigencies of the moment; but let the union, a marriage of reason, of a regiment of Dragoons with a regiment of Hussars, of a brigade of Hussars with a brigade of Cuirassiers, never take place.

Observations by Lecturer.

It is a remarkable fact that in England where there is the greatest love and knowledge of horse-flesh and the best material for cavalry in the world in officers, in men, and in horses, there is no country in which

it is held in less estimation, or where it is the fashion both in military and civil circles, to detract from the value of cavalry as a fighting arm. It is often talked of and treated as a merely picturesque feature at reviews, and the necessity of it even for reconnaissance on service is not admitted by all those who disparage its utility.

The British cavalry has suffered from the tone adopted, from the want of knowledge of the difficulties of making it good, and of the capabilities of the arm when it is good, and lastly, I believe, from not knowing how to use it. We have passed through periods of great discouragement, especially those belonging to the heavy cavalry. I am thankful to say that during the last few years there is some little revival, and there appears to be a wakening up to its importance. The work of the Adjutant-General, "Achievements of Cavalry," did a great deal in this direction, although it is to be regretted that the examples he chooses are chiefly from foreign Armies. This rather points to the fact that in former days, as now, the British cavalry were not encouraged and used as in other Armies, for without doubt there has always been the best material. That, however, does not suffice. It must be worked up and appreciated, and used whenever opportunity offers. Nothing can be more detrimental to the efficiency of cavalry than not to be employed as has happened often, and recently on more than one occasion, with British cavalry. It will surely deteriorate; it can never attain the highest standard, if it has to stand on one side while Native cavalry and other mounted branches are employed on active service, and it will fail you when you require it.

Professional etiquette prevents me from more than alluding to the great encouragement given to the arm by your Royal Highness both in India and at home, also to alluding to what the Inspector-General of Cavalry has done; but in great measure must be attributed to him the steps taken towards a rational grouping of regiments into brigades, enabling them to be drilled and trained in a way impossible formerly. His influence, no doubt, was used in inducing the Government to provide ground in which brigades and divisions can be exercised. I trust that the cavalry manœuvres about to take place this year will in future always form part of the annual training.

It is the fashion in England to assume that while other arms have gone ahead, cavalry has relatively stood still. I maintain, on the contrary, that never has cavalry been so powerful as now.

A cavalry brigade, organised with its machine guns, with its battery of horse artillery, soon, I hope, to be armed with Q.F. guns, its company of mounted infantry and detachment of mounted sappers is a more powerful and self-contained unit for offence, and, if necessary, for defence, than it has ever been before.

It is true that the work of reconnaissance has become infinitely more difficult owing to smokeless powder and the precision and range of rifles. On the other hand, opportunities for the successful action of cavalry have been increased from the following causes:—

The extent of ground covered by armies and the length of their lines of communication.

The duration of battles and consequent exhaustion of troops engaged.

The length and unwieldiness of supply columns.

The exhaustion of ammunition owing to the rapidity of fire of magazine rifles and Q.F. guns.

These are all factors which will give opportunities for the successful intervention of cavalry, and which counter-balance in great measure the improvement in rifles and guns.

I attach very great importance to what General de Négrier says as to the homogeneousness of brigades. A brigade composed of hussars, of lancers, of dragoons, or of cuirassiers, is a far more powerful instrument than a hybrid brigade such as I have the great honour to command, perfect as are the regiments composing that brigade, and equal except in numbers to any regiments in the world. But there are many things to ask for, and I hope some day obtain, before we can arrive at that last element of perfection. The first thing I would ask for is that our regiments at home should have four service squadrons of full strength. Does the British public know that while all foreign nations have four, five, and six squadrons, we have only three? The minimum for French and German regiments is 600 horse, while our strongest have only 475; our weaker line regiments have 340, and our cuirassier regiments 280!

In conclusion, I maintain with General de Négrier that good cavalry properly handled can as heretofore, and perhaps more than ever, exercise a great power on the battle-field, and its use is in no way limited to reconnaissance and providing security, important as these duties are.

It is necessary that cavalry regiments of all ranks, from the general to the trooper, should have complete belief in his arm, and be imbued with the idea of victory, and not of sacrifice, and that they should always remember that it is not the rifle which has to be killed or put to flight, but the man who holds it, and he is the same as he ever was, that is, he has an inborn terror of a man on a horse. Without going so far as the French hussar officer, I feel very grateful to General de Négrier for his outspoken opinion, which will, I hope, be appreciated by all cavalry officers.

Lieut.-Colonel F. EUSTACE, R.H.A.:—Major May, who is detained at Aldershot, has asked me, with your Royal Highness's permission, to read his few remarks on General Talbot's paper, as follows:—

Major E. S. MAY, R.H.A.:—I think we are all, both cavalry and horse artillery officers, deeply indebted to General Talbot for his most able lecture, and for the trouble he has taken to place before us French views on the action of cavalry. I purposely do not use the term "the two arms," because horse artillery should be regarded as an indissoluble part of the larger cavalry units, an adjunct to the squadrons so closely connected with them as to become part of themselves. It is for this reason that I venture, however, to disagree with the suggestion in sub-heading *a* of Section *A*, that where a body of cavalry and horse artillery seeks to interfere with the march of a hostile army or army corps, the guns should act against the head of the column and assail it in front, while the cavalry fall upon the flank. Such tactics imply a separation of the batteries and squadrons, whereas I believe the guns should act in the closest support of their

comrades when they make their charge. It may be, however, that such separation may only be intended to be very temporary, since lower down, in *d*, we are told that cavalry are never to let their artillery work alone. In any case, I am glad to see the action by fire of a large unit of cavalry so prominently brought forward. There can be little doubt that the effect of two or three batteries well supported by carbine fire, would be far-reaching, if threatening unexpectedly the flank of an enemy's line of advance. Even if nothing more than a feint were arrived at, the uncertainty as to what the force making the menace really consisted of must produce a serious result. It would not, in these days of smokeless powder, be possible to quickly discover how many batteries were in action, or whether the bullets proceeded from infantry rifles or from cavalry carbines. A vigorous cavalry might long delay the clearing up of the situation, the onward progress of the hostile force be brought to a standstill, and doubt and hesitation supervene. Again, however, I must differ from General de Négrier in his view as to the breaking up of the cavalry divisions into brigades acting separately on a wide front. You cannot be too strong at the decisive point, and it seems to me that you will do better to concentrate all your energies in one direction, with your batteries massed to cover and support your attack, than to fritter your strength away over a wide expanse. There is one passage in the paragraphs on horse artillery tactics with which I am sure all officers of my arm will agree, and that is where it is stated that horse artillery officers should be horse soldiers in the fullest sense of the term, yet when in action should reverence as gunners the absolute necessity for careful and accurate fire. The two *rôles* are by no means incompatible, but to fulfil the former we need a close association with cavalry, much drill and manœuvre with it, many opportunities of learning its idiosyncrasies. And given a complete sympathy and understanding between the two arms, we need regard the ideas of General de Négrier as to their future place in war as by no means visionary. Of course he sometimes speaks the language of a somewhat warm enthusiast, and we can hardly join him in his visions of piercing lines of battle 30 or 40 miles wide, but at least we can appreciate what the sudden inroad of a powerful force of cavalry and horse artillery on the flank of widely-extended lines might mean. I saw such an attack carried out by a cavalry division with two horse batteries during the French manœuvres near Amiens last September. The plan was quickly conceived, and the blow delivered with much adroitness. No doubt many saddles might have been emptied in that enterprise; but no one, I think, who saw the surprised infantry huddling together into groups but doubted that the attack on that flank must have been brought to a standstill for several hours.

Lieut.-Colonel F. EUSTACE, R.H.A:—I will only add a few remarks to those of Major May. First, I must say how fully I agree with General de Négrier and Major May in what they say about horse artillery officers, and the need for constant close association of cavalry and horse artillery. I had the good fortune to be present last year at the Amiens manœuvres, and to see something of the working of cavalry divisions, of which there were four, each with its brigade division consisting of two batteries of horse artillery; and although they worked somewhat slowly, it was very evident in which divisions the cavalry and horse artillery had been accustomed to work together and to play each other's game, and in which divisions (one in particular) they had not. There is a chance for us now which we never had before, on the new ground near Salisbury. May I be allowed most respectfully to urge the vital importance of every opportunity being taken of bringing the cavalry and horse artillery together there. Nothing but constant practice can give the commanders a fair chance of making the best of their squadrons and batteries in the very difficult task which is set them.

Major-General G. UPTON PRIOR:—Your Royal Highness, Not being a cavalry officer, it is with some diffidence I venture to make any remarks on the present occasion; I had no intention of speaking, but it seems to

me a poor compliment to so interesting a lecture to pass it by without a discussion. The *service of intelligence* mentioned by the French general, by which selected officers, mounted on specially fast horses, are attached to the staff of a cavalry general for the purpose of giving him the latest information, seems to me well worthy of imitation and introduction into our Service, and that it should be given not only to cavalry generals, but also to all generals in command of army corps, and to those of lower rank who have an independent command. I hardly agree with the idea of the French general that it is more advantageous for infantry to be able to march well than to shoot well. It seems to me, as an infantry officer, that the first thing of all others that an infantry soldier should excel in is shooting. Of course he must be able to march too, but it would be a pity to let him think that anything goes before shooting. It seems to me a battle is more likely to be won by good shooting and bad marching, than by good marching and bad shooting. The question of the possibility of cavalry charging infantry is a very old and interesting one. The factors excepting one are the same now as of old; the men are the same, the horses are the same, the ground is the same, and the men's nerves are the same; but the factor which is not the same is that of arms. Those of the infantry have improved vastly, whilst those of the cavalry are pretty much what they were of old. We cannot compare the shooting of the "Brown Bess" with that of the Magazine rifle, which with virtually no trajectory sends a bullet skimming some 6 or 7 feet above the ground up to a range of 500 yards. Again, the smokeless powder used enables the men armed with these rifles to see cavalry much further off than of old. Taking these facts into consideration I think the chances of the dice are more against cavalry than formerly. Of course there is still the possibility of cavalry surprising infantry, or catching them without ammunition. With regard to the desirability of a general officer using his cavalry for charges, or in other words, as a fighting machine like other arms, it seems to me to depend on two things, viz., the amount of cavalry he has, and the emergency. If he has plenty of cavalry, so that the loss of a regiment of cavalry is of no more consequence to him than that of the loss of a regiment of infantry, then by all means use cavalry for fighting purposes as much as the other arms. But cavalry is so expensive an arm to keep up, and so difficult a one to train, that I cannot conceive the possibility of any general having such an *embarras de richesses;* he would require all he has for the ordinary work of giving him information, preventing the enemy obtaining any, and to pursue a beaten enemy. To put a common-place example, one may liken two armies fighting to two prize-fighters. The artillery and infantry represent the arms or hitting powers of the prize-fighters, the cavalry their eyes or seeing power. Now if one of the prize-fighters forces the fighting, hits freely, and accepts punishment, not trying to protect his eyes, he may gain a temporary advantage and win the fight; but should the fighting go on any length of time he runs considerable risk of losing through his eyes closing up, even though his arms are in as good condition as at the commencement of the fight. On the other hand, it would certainly be desirable for a general to use cavalry for fighting when the emergency was such that the fate of the battle or campaign depended on such use of his cavalry. The lecturer has presented us, if I may say so, with two very good instances of the proper use of cavalry for fighting. The first instance was that of their use on the 13th September, in the manœuvres under discussion, when the cavalry extricated their infantry from a very awkward position and gave them time to make an orderly retreat. The second instance was that of their suggested use in an emergency, when a big battle, covering some 30 or 40 miles of front, has been raging in an undecided way for some time, and is won by the charge of a huge mass of cavalry made at the right moment. As regards the question of an attack formation for large bodies of cavalry, this is as vexed a question as the similar one for infantry. The reasons given against one for infantry are that such

a formation cramps initiative, and that any regular advance of a really big force is impossible, because the long front must become irregular by parts of it being interfered with and checked at any moment by accidents of the ground as hollows, woods, obstacles, etc., or by an enemy's resistance being stronger on one portion of his front than at another. But even with these disadvantages Prince Kraft (than whom there are few better judges) advocates an attack formation for infantry, and brings forward the battle of Le Bourget as an example. And there can be no doubt that a regular formation of some sort lets every commander know what his neighbour is doing, and how he means to do it; and also when large numbers are engaged, prevents men shooting their own comrades. Now it seems to me that all these arguments can be applied to the question of an attack formation for cavalry, but with very much more weight because of the pace cavalry go when charging. If there were no formation at all when the order to charge was given, which would guide commanders as to their relative positions in the mass, it is quite possible that one commander possessed of initiative and seized with a brilliant idea, might collide with another commander of equal originality and brilliancy, but possessed with an idea which would bring his regiment into that of his comrades before either had time to stop his regiment. Seemingly then it would be advantageous that large bodies of cavalry should have some sort of attack formation when charging. I quite agree with the other conclusions of the lecturer, especially as to the desirability of inculcating in every cavalry soldier that when he meets infantry he has every chance of defeating them, so that when he is told to attack he does so with every confidence of victory. As the lecturer says, regulations have a very great influence upon the opinion, and upon the spirit of an arm. In conclusion, I would hope that this interesting lecture, and the fact of your Royal Highness being in the Chair, may draw public attention to the advisability of increasing the strength of our cavalry—a necessity which is all the more pressing when we know how largely foreign nations have increased, and are increasing, theirs.

The CHAIRMAN (H.R.H. the Duke of Connaught):—Ladies and gentlemen, I had hoped there would have been some other officers who would have given us the benefit of their opinions and their experience on the lessons to be derived from the very interesting lecture which has been given us by General Talbot; but as, unfortunately, except those gentlemen who have so kindly spoken, nobody wishes to rise, it rests with me to wind up the discussion. I wish that a very sharp attack of hay asthma were not with me, for I may break down at any moment; but you will excuse me if it happens. The lecture is a very remarkable one in the very sound cavalry views expressed by a purely infantry general. I only hope that all our own infantry generals also take such an interest, and show such a knowledge of what is expected of cavalry as General de Négrier. There are one or two points which I think come out very strongly, and one I have alluded to at Aldershot once or twice, and that is, the great importance of the different arms knowing each other, knowing what they exist for, and how important their mutual support is to one another. I think that of quite recent years there has been a great advance in the views of all officers with regard to the important *rôle* that cavalry would play in the future. We have not always been lucky in the opportunities we have had of working the different arms together; we have too often had to work infantry by itself, artillery by itself, or cavalry by itself, and only a very few years ago cavalry seldom had the advantage of working with the horse artillery as it does now. I am entirely at one with Major May and Colonel Eustace in the importance of all tactical cavalry work being carried out in connection with the horse artillery, which forms part and parcel of the cavalry brigade, and which should always be kept informed of the cavalry general's intentions, and should be left to support him in the manner best suited for horse artillery. Now we have a lighter gun for the horse artillery,

I think the mobility we had lost a few years ago has come back again, and I have on recent occasions been delighted to see the rapidity with which horse artillery batteries have changed their position with a view to supporting cavalry charges. I think every cavalry soldier should have that pride in his arm which, I am sure, all those cavalry officers whom I am addressing have. There are many officers here whose views are well known to me. I think it was a very true remark of General de Négrier, that when infantry are on the march they can very easily be caught at a disadvantage, and therefore it is essential that they should have some flanking protection, if possible, combined of all three arms of the Service. I am entirely at one with that opinion. I hope this lecture may increase the interest in the cavalry arm, not only of cavalry officers, but of infantry officers, and also of the country in general. No one would rejoice more than myself if I thought we were going to have a fourth service squadron. I hope the country may recognise that cavalry, to be efficient, must have a certain strength, and if you do not give sufficient money to allow that cavalry to be of a strength which is considered necessary in all foreign Armies, that cavalry is at a disadvantage with those foreign Armies. The present Inspector-General of Cavalry has, I know, done everything in his power to get stronger cavalry regiments to reduce the number of dismounted men, to get rid of old horses, and also to avoid remounts going out to manœuvres, etc., and all this is beginning to have a good effect. I am sure that anybody who should go down and see the cavalry brigade under the command of our lecturer, would say that he never saw better men or men better commanded; but he would also say, "What a pity they are so weak!" So I, with the lecturer, hope that a lesson will be derived from this lecture as a sample of foreign opinion. I think I may say that German opinion is very much the same, and I am glad to see here, for the first time, our German military *attaché*—he will bear me out in saying that the opinions of German cavalry leaders had a very important part in the recent alteration of tactics in the German Army. My lamented father-in-law, Prince Frederick Charles of Prussia, was one of those who thought that there was nothing to touch well-commanded cavalry; he inculcated into the minds of all cavalry soldiers that they could not be defeated, that their dispositions, properly made and properly carried out, with a strong feeling of confidence in themselves, were sure to carry with them success. Gentlemen, I thank you very much for having listened to me, and I am glad my voice did not break down.

A SUGGESTED CORRECTION OF THE ACCEPTED THEORY OF THE TIDES.

By the Rev. J. H. S. MOXLY, Chaplain, Royal Hospital, Chelsea.

Wednesday, May 11th, 1898.

Rear-Admiral Sir W. J. WHARTON, K.C.B., F.R.S., Hydrographer of the Admiralty, in the Chair.

INTRODUCTION.

THE fact that the current theories of the tides fail to account for many important "facts of observation" as to tidal movements, and that very many instances occur in which theoretical results are flatly contradicted by the actual events, must be my excuse for the following attempt to formulate a theory whose results will be in harmony with Nature. If a theory as to the causes of any constantly recurring natural phenomena be true, its truth should be seen in the accordance of the theoretical results with the known results for which the theory is supposed to account. If the theory be sound, each new fact of observation should be seen to fall into its place and be but an additional support to the theory. When a theory is found to require the assistance of unverified or unverifiable hypotheses to account for the existence of new or newly recognised facts, it is either false or inadequate. That theoretical results, in the matter of the tides, are in manifest contradiction to many of the generally recognised facts of observation is undeniable. A few notable instances of such contradiction may be given.

The equilibrium theory (as it has been understood and applied), the theory of Laplace, the wave theory, and the calculations of the late Astronomer Royal all agree, we are told, in giving a diurnal tide which vanishes at the equator and at the poles and is greatest at middle latitudes. But by the unanimous consent of astronomers and observers, this diurnal tide is found at places near the equator in as great amplitude as it is in middle latitudes, and also so far north as Petropavlofsk and Sitki Island it suffers no diminution.

The Pacific Ocean is specially mentioned as affording a good opportunity for testing the theoretical result—that there should be no diurnal

tide near the equator or towards the poles—but it is in the Pacific Ocean that the failure of the theory to agree with facts is admittedly most "complete"; all the most conspicuous diurnal tides being found in that sea, and at latitudes at which, theoretically, they have no existence.

Then Laplace found that if the sea were of uniform depth there would be no diurnal tide at all, at least in elevation, "for the expression for its elevation absolutely vanishes." Well may this be called "a most remarkable and most unexpected result."

The question remains, notwithstanding Airy's surprised acceptance of this "result" and its apparent extension by recent writers, Is it true? And to this I believe the answer should be a decided negative. If by "diurnal tide" be meant the excess of one of the semi-diurnal tides of the lunar day over the other at any place—and I hope to show this is all the phrase can mean—it will not be difficult to see that this difference ought, at many places, to be well marked, and can only disappear *owing to exceptional causes*.

In one important case, too, unmerited ridicule has been heaped upon the despised equilibrium theory. I allude to the passage in which Sir George Airy makes the following supposition, which he himself calls "absurd." I quote the passage *in extenso* lest it should be thought there must be some misunderstanding on my part. "Suppose now," the great astronomer says, in paragraph 34 of the "Treatise on the Tides," "that the water assumed the form which we have found, and that the earth revolves within its coating of water. (This supposition, absurd as it is, is the only one upon which it is possible to apply the equilibrium theory.)"! Surely no reverence for authority should be allowed to blind us to the mischievous error involved in this remarkable statement! It is, as Sir George Airy truly says, "absurd," but not more absurd than unnecessary. For it is a state and not a body that is permanent in this case, whereas the absurdity of the supposition lies in the supposing that it is the water, which at any moment composes the wave-form, that remains with the moon, the solid nucleus of the earth with its protuberant continents and islands sweeping through this water at the rate of 1,000 miles an hour. Fortunately that is not "the only supposition on which the equilibrium theory can be applied," for there is another—that which truly represents the facts of the case—namely, that the earth with its coating of water rotates through a wave-form. There is no absurdity here, nor is there any difficulty in applying the equilibrium theory upon this supposition.

Again, the explanations offered us of such phenomena as the extraordinary tides of the Bay of Fundy and those of New-Archangel in Sitki Island and of Petropavlofsk on the opposite shore of the Pacific are surely quite inadequate. Indeed, as to the two latter phenomena, no explanation is attempted. The phenomenal tides are simply mentioned and then abruptly left as inexplicable mysteries.

The diurnal tides, perhaps, behave in the most irregular manner of all. They come and go just as if at their own independent will, preceding the semi-diurnal tide at one port, and following it at another port a short distance off. For example, the diurnal tide is found to be some 2¼ hours

in advance of the semi-diurnal at Brest, while at Soutnampton it lags behind the semi-diurnal tide by several hours—four or five hours, Sir George Airy says, loosely, as if there were but little accuracy to be expected from it. Where the diurnal tide went when it passed Brest does not appear, or how it is that between Brest and Southampton the semi-diurnal, which was 2¼ hours behind at Brest, overtakes it, passes it, and arrives at Southampton some four or five hours before it. Quite inexplicable! This diurnal tide is so lawless that no decent hypothesis can be persuaded to have anything to do with it, and the conclusion of the whole matter is that "we cannot at all explain the co-tidal lines for the tides of the ocean." In these words Sir George Airy gives the matter up, and so far as I can find, no further attempt to account for these irregularities has since been made. That the law of the tides is at the present time hidden in deep obscurity will be abundantly plain from the following official statement made in the Tide Tables of the first maritime Power in the world. "There are perhaps few physical subjects which are still, at the present time, on the whole more unsatisfactory" (*vide* Appendix No. 2, British Admiralty Tide Tables for 1898). Indeed, a glance at the pages of this official publication is sufficient to show the inextricable confusion in which the current theories have left the whole subject. On page after page we see footnotes alluding to particular "complicated" tides, anomalous tides, and abnormal tides. Surely the presence of such a statement as the following is enough to arouse a suspicion that the true secret of the tides has as yet escaped us. In Appendix No. 1 of the Tables we read: "Though the tidal force of the sun in theory is the same at all places, it is found by observation to be different at different places."

That sentence fairly sums up the position. The theory says one thing, the facts of observation tell quite a different story! Or take the next paragraph in the same Appendix:—"In general the rise of spring tide above mean water . . . gives the solar tide one-third of the lunar tide. But in some cases the spring tide . . . gives the solar tide only one-seventh of the lunar tide." And I have lately learned that a recent series of observations gives the solar tide as but one-seventeenth of the lunar tide. Comment, one would say, is needless! The subject is indeed in a condition which fully justifies the able editors of the book when they speak of it as "at the present time unsatisfactory."

To conclude this prologue, I would sum up: Every theory of the tides, as at present expounded, leads to results which are in absolute contradiction to the observed facts. Unverified, and unverifiable, if not improbable, hypotheses are called in to help out the theories. The explanation of some of the known phenomena is inadequate, while of many of the phenomena no explanation can be given. The theories fail most completely (according to the greatest astronomers), and are most in need of the support of new hypotheses just where they might reasonably be expected to stand most firmly "on their own feet." The official experts of the British Admiralty plainly inform all concerned that, in the circle of the physical sciences, there are few subjects of which our knowledge is in so unsatisfactory a condition.

There is room, then, for an attempt to expound a theory the results of which may be seen to be in concordance with facts.

I hope it will be seen that the utmost harmony, under the law of gravity, prevails in every sea and tide-way, and that even the most striking "irregularities" are absolutely regular results, inevitable and inexorable results, of recognisable conditions.

I.—The Corrected Theory.

What, then, is the new theory with which I would replace those which have held the field? No new theory! but rather an adaptation and development of the oldest of the theories of the tides—the equilibrium theory.

It is true, it is for this theory that all the vials of some of the greatest astronomers' scorn were reserved. After long consideration it was set down by Sir George Airy as "the most contemptible theory ever invented to account for natural facts"; it was spoken of as "this miserable theory," and in short, there was nothing too bad to say of it: "its principles were absolutely false," and "its results were absolutely untrustworthy." And yet it can, I think, be shown to hold the key to every puzzle that has exercised the minds of those who have striven to understand the law of the tides. It explains every difficulty, or rather it shows there is no difficulty, and that there never would have been a difficulty, had its principles been followed out.

What appear, at first sight, to be difficulties in the way of the acceptance of the theory as a full explanation of the facts of observation are found eventually to be the strongest confirmations of its absolute truthfulness to Nature and natural law. Supported by the belief that Nature is everywhere uniform in her obedience to law, and that not even the boundless ocean is free from the universal rule, let us examine this matter, and it will, I hope, be seen that the apparently insurmountable obstacles are but corroborations, and afford, in every case, striking illustrations of the truth of Newton's grand generalisation! The contemned equilibrium theory conducts us into the very arcana of the ocean. Complications, anomalies, abnormalities vanish out of sight; in their place is simple, eternal, omnipresent law, within whose realm lies even the vast and wandering ocean.

But what, then, is this adaptation? Let me clear the ground, first of all, by getting rid of some phrases which have possibly done much to hinder the course of true thought: such phrases as "the moon draws up the tide"; "drags up the tide to Liverpool," or elsewhere; "heaps" or "holds up the tide," and so on. These phrases are, I think, misleading, and therefore cannot but be harmful. I object to such phrases as the moon "drags up the tide," or "holds up the tide," because in fact, the moon *cannot drag up the smallest particle of water*—no, *nor a particle of air*—and I think knowledge would be better served by a true statement of facts as they are.

But what, then, is the moon's share in the production of the tides?

Her "differential attraction" gives an opportunity for the pressure of the earth's gravity to heave up a tide; that is all!

A story will illustrate my meaning. Nearly forty years ago some boys in a country place in Ireland obtained possession of a new, and I think *then* a "new-fashioned," football. It consisted of an inflated sphere of some elastic material covered by a leather case, which was closed by being drawn together by a leather thong. When the case had been fully inflated, and the cover drawn tightly over it, and the thong knotted, we found our football a delight; but on taking it out on a wet day for play, the damp contracted the leather, only to make the ball still better for its purpose, till a kick cut the knotted thong, when we found the whole seam gave way, and the inner case bulged out considerably through the widening opening in the outer case. We had considerable trouble in getting the leather to meet again, for the inner case continued to bulge out wherever it had opportunity.

Now, a boy had certainly loosened the fastening of the outer case; but would it be fair to say he had "dragged up" the inner case through the opening? Surely not! The pressure of the outer case had been removed from one region of the ball, and the pressure of the part which remained did the rest. The pressure (*i.e.*, of the remaining part of the outer case) forced up the inner case through the opening that had been made.

That, I take it, is exactly how the *pressure of the earth's gravity* produces the tide! For supposing, for a moment, the moon and sun did not exist, the water on the earth's surface would be everywhere drawn towards the earth's centre by an equal force, that of the earth's gravity, and there would be no tide. Now suppose the moon introduced, and her attractive force, or gravity, will counteract in a very minute degree that of the earth. This attractive force of the moon will be greatest at the point on the earth's surface between the centres of earth and moon; that is, in effect, the pull towards the centre of the earth will be less at this point than at any other on the earth's surface. In like manner it can be seen that at the point on the earth's surface opposite the moon through the centre of the earth, the pull towards the centre of the earth will be less than at any other point on the surface of the hemisphere remote from the moon, while the pull towards the centre of the earth will be greatest along the great circle passing through the points of quadrature; the pressure, that is, towards the earth's centre will be the greatest along this circle, and the water will be literally squeezed away from that circle towards the points where the pressure is less.

To put the matter in a nutshell: the tide, as I see it, is the result solely of difference of pressure, while the tide of the astronomers is considered due to that component of the moon's tidal force which is called "tangential," a force which would tend to produce, and is supposed to produce, an actual movement of water or a current. In a word—the tide of the astronomers is a tide of "drag," and mine is a tide of squeeze!

It is the calculation of this tangential or dragging force, and the neglect of the normal or pressure force, that has done all the mischief and produces the puzzles of the tides.

In calculating the accelerating influence of one planet upon another, that is, the influence of one planet in elongating the major axis of the orbit of another planet, astronomers reject normal force as having no influence in that direction, for "variation of the length of the axis is due entirely to the tangential force, and is quite independent of the normal" ("Outlines of Astronomy," Herschell, p. 420), and then when they come to calculate the effect of the differential attraction of the luminaries upon the surface waters of the earth, they adopt the same procedure. In the latter case they are absolutely wrong. Normal force is rejected in the former case because "it tends merely to alter the curvature of the orbit" ("Outlines of Astronomy," p. 420), but in the latter case it is just this alteration of curvature of the surface of the earth that produces the tide.

In calculating the height of the tide we are calculating really the elongation of the axis, not of the orbit of the earth, but of the earth itself, that is, the axis of the tidal spheroid! How such a confusion of these axes came to be made I cannot tell, but the mistake was a fundamental one. *Hinc illæ lacrymæ*, or hence the abnormalities of the tides.

Again, tangential force as a motor power, producing a current in the water, can easily be seen to be infinitesimal in proportion to the work it is supposed to do.

For the sun the mean motor power of this force is equivalent to a pull of 1 lb. upon 30,000 tons of water. What will be its effect in causing motion of the body of water? Absolutely none! One might much more reasonably ask what the effect would be were an infant of a day old to endeavour to pull over Nelson's pillar in Trafalgar Square. The idea that the tide is caused by a current produced by such a force is, to me, nothing short of ridiculous. And yet this is the explanation of the tides given in modern text-books on astronomy, for instance, in "Brinkley's Astronomy, revised by Professor Brünnow," the text-book used in Trinity College, Dublin. On this explanation of the tides the notion that the tide on an ideal earth would be, not under and opposite the moon but 90° behind her, is based; a notion that has proved a fruitful parent of misconceptions!

I assert, on the contrary, that it is the normal force or that causing variation of pressure towards the centre of the earth that is the sole cause of tide. Anyhow it passes my poor wits to see why normal force should be totally neglected in favour of a force that can be seen to be not nearly half so great.

Even the local differences of atmospheric pressure have great influence in elevating or depressing the surface of the water. The Admiralty Tide Tables (p. xv.) give a rule that a variation of barometric pressure of an inch will produce an alteration of the level of the water of 20 inches.

Sir George Airy knew of this increase of the elevation of the tide corresponding to decrease of atmospheric pressure; but the fact merely

added one more to the many puzzles, and he says (para. 572):—"The explanation of this circumstance by considering that a heavy atmosphere acts as a weight pressing down the water is plausible enough, but . . . . we cannot say that it is quite satisfactory." The fact, one would think, might have called attention to the importance of pressure and so of normal force as tide-producing; but the preconceived idea that this force might be neglected carried the day, and the lesson was unlearned.

It is noticed, too, that this variation of pressure produces its effect at once and at the spot where the increased or lowered pressure is, and that there is no retard whatever of the tidal movement produced by it; but no lesson was drawn from that fact either. Well, the astronomers neglect normal force, and I neglect tangential, and when I have said in addition that friction will not practically delay transmission of pressure in an incompressible fluid, and that the influence of varying pressure due to normal force will act proportionately in every sea, I have laid down the basis of my scheme, according to which on an ideal world the tide will be under and opposite the tide-producing body, and in our world will occupy that position where it may have the chance.

For the rest, shoaling sea floors, especially where the shoal terminates in islands, and more especially where it leads up to a continent, will sweep the water before them and thus delay the tide—in places for several hours—but such delay will be periodic and constant, and will not alter the behaviour of the tidal movement otherwise, at least, to any great extent.

That the tidal spheroid would normally lie, as I have said, becomes, I think, certain when we consider the evidence given by the present shape and position of the moon herself. For the moon is known to be ellipsoidal and to have her longer axis pointing towards the earth. Newton himself found that this should be the case, and the only difficulty was that modern astronomers found that the difference in length of the moon's axis was too great to be accounted for by the tidal force of the earth exerted upon the moon while she was yet fluid. The moon is in fact too egg-shaped—too much drawn out towards the earth and too bluntly rounded on the side remote from the earth—to have taken that shape under the present tidal force of the earth at the moon's surface.

So the matter rested; but now that Professors Purser, Darwin, and Sir Robert Ball have shown us that, at a remote period, the moon and earth were very much closer together than they are now, I do not see any difficulty in believing that the shape of the moon is exactly what it ought to have become under the influence of the earth's tidal action on its once fluid mass. As the moon cooled she retained the shape she had all along preserved, and that shape could only have been given by her tidal spheroid's lying with its greater axis pointing towards the earth. The evidence for this position of the tide is thus written, not only on the earth, but on the sky!

I now pass on to ask and answer the pertinent question whether the "facts of observation" are in accordance with my theoretical results or

whether they are in disagreement. It will be remembered that when the theories of Laplace and Airy are brought to the test of practical experience they "fail absolutely," and fail most conspicuously just where the earth's oceans possess most analogy with the ideal oceans for which the calculations were made. I assert, on this, that a theory which absolutely fails in such circumstances should not be taken as true. I must not refuse to subject my own theory to the same process, and no matter how plausible it may in itself appear to me, I must decline to stand godfather for it if it fail me. "To the law, then, and to the testimony"!

II.—Concordance of Theory and Fact.

I have said that, in the nature of things, high water should be under the moon, whereas it is the generally received doctrine that it should not be in that position, but, in fact, 90° behind it. Even in such a world as ours an appeal to the "facts of observation" should enable us to form a reliable judgment on the question. But mark, I have not said that, in such a world as ours, the most noticeable tide will be in all cases under the moon. What I do say of such a world as ours is that wherever there is a possibility for the tidal wave-form to have an unimpeded course round the earth at any parallel, there the tide will be under the moon. And further, should this possibility exist, and the other oceans be comparatively narrow—the narrow oceans opening into the tidal belt of water—the noticeable tide in these oceans will be derived from the tidal belt, and this derived tide will proceed along these oceans with a speed depending on the depth of water, and a height depending very much upon the configuration of the shores and the slope of the sea-floor at and near the place where the tide is measured. The main tide of the seas and narrow oceans will, in fact, be a derived tide, that is, a tide derived from the belt across which what I shall call the true tide is passing.

Where, then, on the surface of the earth, shall we find a sea in which it is possible for a tide to follow the moon in her passage from east to west around the world? On looking at a map of the globe we find that nowhere does such a sea exist except in one region—that of the Southern Ocean. Here, and here only, there is a stretch of water round the earth. From the 40th parallel to the 70th there is open sea across the world, interrupted only by the tip of the South American continent, and by certain islands at a great distance apart. Here, then, we shall be able to see whether the tide is under the moon or 90° behind her. The islands will give us the most reliable information, and the smaller the island and the further it is situated from a continent the more trustworthy will be the record it gives as to the time when the true tide passes it. There are but three such stations in this belt of ocean where, so far as known, the time of high water at full and new moon has been observed—the extreme south-west point of Stewart Island, Kerguelen Island, and South Georgia. Of these, South Georgia is too near the South American continent to escape some retardation of high water, owing to the great retard produced along the Patagonian coast. This coast-line, sweeping

forward into the region of elevated water, necessarily sweeps the raised water before it, piling up a tremendous tide in St. George's Bay and, indeed, along many hundred miles of South America. The great retard and elevation of this tide must influence in some degree the time of highest water at South Georgia. But such as the position of the islands is, we must take them. It is a case of "Hobson's choice." Well, then! On opening the chart of the world showing the co-tidal lines (published with Sir George Airy's treatise, and again adopted by Professor Darwin in his treatise on the tides, in the "Encyclopædia Britannica") I notice that on the meridian of Greenwich the high water is placed in the open sea of the Southern Ocean as directly under the moon.

Eastwards at Kerguelen, across several thousand miles of sea, the tide is again placed under the moon, and westwards to South Georgia again the high water is marked as nearly under the luminary. In the latter case, indeed, I should, owing to the reason given above, have expected a greater retard than that given by Sir George Airy.

On looking to the southern extremity of Stewart Island, I find that the Admiralty Tide Tables give the time of the high water there as twelve o'clock, or again precisely under the moon.

We have thus traced the track of the tide across the sea for a space of 210° of the circumference of the earth, and along all this distance the tide has kept under the moon! It is found, in fact, just where my theory says it ought to be. But further, from South Georgia to Stewart Island the tide has an unimpeded course over some 150° of the earth's circumference, and at South-West Cape, Stewart Island, it arrives with the moon. True, we have not been able to trace its path or time its arrival at any point along this last 150°—no observations have been made, or none that I have seen recorded—but the inference to be drawn from the facts we have is plain, and is, I think, conclusive. From South Georgia to Stewart Island, from Stewart Island to Kerguelen, and thence to South Georgia again, the tide has kept its theoretical place, and passes the meridian of Greenwich in the open sea precisely at twelve o'clock on days of full and new moon. I do not know that we can ask for much more. Now, here was a test case! Here, if anywhere, was the statement—that the uninterrupted true tide is under the moon—to be judged, and here the statement agrees exactly with fact.

The theory as to the diurnal tides of the astronomers "fails absolutely," and fails most absolutely—if my double superlatives may stand—where it should have stood the test best. It is not too much to say that the current theories fail generally to agree with facts; so much so that Sir George Airy was driven to confess that "we cannot at all account for the position of the co-tidal lines of the ocean tides." Now, here I have no need for a hypothetical refuge; for the tide, where it has a chance, is as regular as the sun and moon themselves, and equally with them just where it ought to be. I am fain to point out the contrast of results so far obtained from my "scheme," with the results obtained from the former theories. So far as I have gone—it is not far,

but so far as I have gone—the agreement between theory and fact is perfect.

To proceed to the next step. How, on my principles, are the co-tidal lines and the phenomena of the tides generally in the Atlantic Ocean to be explained? There is really no difficulty. The tide is in its due place at the due time. The true tide *under the moon*, save when the actual time of highest water—a different thing, as I hope to show—is delayed by shallowing seas, where all tides will necessarily "drag," according to my view, and also according to the accepted theories, and where the tidal wave, also necessarily, becomes a tidal current; the derived tide—in the case of the Atlantic the principal tide—following its course as a free wave, its velocity depending upon the depth of the sea it traverses. For the Atlantic this velocity is found to be, at all events as far as Cape Clear, some 520 miles an hour, or roughly what a sea of a depth of 3½ miles would have it.

Let there be a port or island then in the Atlantic, situated 3,000 miles north of the opening of the Atlantic upon the Southern Ocean, and it will require a period of nearly six hours for the great tide to arrive at the port.

But what then? Is that surprising? Is it puzzling? Surely not; and there is no reason to speak of the "irregularity" of the moon's action, or to say "the moon has travelled 90° to the westward before she *has succeeded in dragging up the tide to the place*"![1] It will be incorrect to speak so, not only because the moon is quite incapable of dragging a single drop of water after her, let alone a mighty tide, but it will be incorrect, because at the moment of high water at the island, the little influence the moon is exercising upon the narrow sea is exercised in giving an opportunity to gravity to make it low water there and not high water.

As the point of observation is chosen remote from the origin of the derived wave or near it, so the true tide will precede the derived tide by a greater or less interval, until if you take your point far north enough the true tide will precede the derived one by twelve hours, *i.e.*, it will coincide with the derived tide which started on its way twelve hours before. Where this is the case the combination of the two tides will produce an extraordinary height of tide, I mean a tide higher than the ordinary or average tide of the sea.

Now let us see if there is any place on the coasts of the Atlantic where this *must* happen. Above latitude 5° N., *i.e.*, above the comparatively narrow passage between Cape San Roque and Sierra Leone, the Atlantic spreads out rapidly to the west. The derived tide will therefore take a more westerly direction, and by the time it reaches the North American coast, about the 45th parallel, it will be running chiefly west, or perhaps north-west, and so right against the shore of the sea there, and not along it. This tide will therefore be piled up. Now, if you look at the co-tidal chart of Sir George Airy, you will see that the tide which

[1] Sir Robert Ball in "Time and Tide."

left the Southern Ocean at time of full-moon does not arrive as highest water along the coast of New Hampshire and Maine till more than 17 hours afterwards, and so the time when the full-moon derived tide has reached the entrance to the Bay of Fundy will be the same as that of the arrival of the true tide under the moon of the following day. The two tides thus coincide, and as they are, on the coast of Maine, running in the same direction, we might reasonably expect a tide of extraordinary height. The great combined tide striking against the coast of Maine is reflected back against the Nova Scotian coast, and, as it were, trapped in the Bay of Fundy. There is no escape for it, and the level of the water in the bay rises to an unusual height. We have, in fact, and ought to have, the greatest tide in the world.

There are extraordinary tides in the bay because there are extraordinary opportunities. Nowhere else in the world do two such tides combine; nowhere else is such a trap prepared for them!

III.—Interpretation of Formulæ.

I have mentioned above the so-called diurnal tide. I may here plainly state that I do not believe in the existence of any such as a distinct tide, or as a tide supposed—in the words of Sir George Airy—to "follow the moon's transit after a variable interval" and to have a value as a separate tide which in the latitude of London "ought to be equal or nearly equal to that of the semi-diurnal tide"! I cannot express too clearly my view on this point, for it is a crucial one, and I am willing to stand or fall by it. There is no diurnal tide as separate from one of the semi-diurnal tides, and when observers suppose that they find one they are absolutely mistaken. Such a tide is in the nature of things impossible. What observers find in the North Atlantic is what I have called the true tide. This, in the nature of things, must exist. The "diurnal tide" is a myth! I admit the impertinence of the statement unless I have sound and indubitable reasons for making it—that is, unless I can justify it. To my reasons let me therefore turn.

My point is, that there cannot be a diurnal tide *as a separate entity*, *i.e.*, separate from one of the semi-diurnal tides under or opposite the moon. This I shall proceed to show, first on what I may call principles of common sense, and then go on to show how my common-sense inferences are borne out by the beautiful formulæ of the astronomers and by the facts of observation!

First, then, let us suppose ourselves removed so far from the earth that we can mark the summit of the cone of water facing the moon and trace its course. We are ignoring, for our special purpose, the sun and his influence as a "tide-producing" body. What, then, shall we see? In the first place, that the apex of the water cone of our ideal earth (completely covered by water) is moment by moment changing its position with reference to the earth beneath it. The summit of the cone, in fact, is moving across the surface of the sea as the earth rotates beneath the moon. This motion is, in the main, east and west. But not thus alone; for the moon does not keep the same position with reference to

the earth's axis of rotation and equator, but is moving north and then south with a steady motion. To-day she is directly over the equator, and the summit of the water cone is on the equator too. To-morrow we see that she has moved somewhat to the north of the equator, and the cone, with its apex directly under her, has that apex north of the equator also. The next day the moon is directly above a point still further from the equator and nearer the north pole. And day by day as the earth rotates under the moon, the line joining the centres of the earth and the moon passes through a point—the apex of the tidal-cone—which is further from the equator and nearer to the pole than it was the day before. The daily path of the moon across the earth, then, is a spiral, and the apex of the cone has made a spiral of some seven whorls when the moon begins to return southwards, the cone apex under her always. In a fortnight from our starting-point of time she is over the equator again, and a week later has reached her south tropic, some 29° S. of the equator, as her northern tropic was 29° N. of it (that is, taking the extreme case of declination). And so her course proceeds till at the end of the lunation she is again over the equator whence we saw her start. Now, we have been all this time watching one cone of water with one apex, that is, we have been tracing the progress of the point of highest water, and we found its path a spiral; the highest water being at one time on the equator, then at a point 29° N. of the equator; then on the equator again, and then at a point 29° S. of it. If we have also been watching the position of the region of lowest water, we saw that it too necessarily shifted, the great circle forming the base of the tidal cone and the line of greatest pressure at one time—when the moon's declination was north—containing within it the north pole, and not the south pole; during the other part of the lunation, when the moon's declination was south, containing the south pole, but not the north pole.

I am speaking of the tidal hemispheroid facing the moon; it is over that hemisphere our supposed point of observation is. But what we have been watching all this time is one tidal wave-form, with one summit. It is the path of one apex, *i.e.*, of one highest water, we have been tracing. Where is there room for any other tide? There is surely none. Astronomers tell us of a diurnal, of a fortnightly, and of a half-yearly tide; of tides of evection and of variation, and many another; but we have seen no such as distinct and separate tides, each with a speed of its own and "following the moon's transit at a variable interval"!

The mathematical formula which will give us the height of the tide at every given place and time must necessarily contain elements or expressions taking account of the movements of the moon and sun north and south of the equator, and of the consequent swaying of the axis of the tidal spheroid, and also elements due to the varying parallaxes of the luminaries, and to the alterations of ellipticity of orbits; but to separate the general expressions for the height of the tide into these separate elements, and then to treat and speak of them as giving tides, separate and distinct from one another, each with its own velocity and following the moon at its own independent interval, is, it appears to me, not

warranted by the facts of Nature, and seems to have led to serious misconceptions. Let us analyse for ourselves the general expression for the elevation of the tide on the equilibrium theory as given by Sir George Airy. As finally arranged, this expression is the following:—

$$(1 - 3\sin^2\lambda)\left\{ M'\left(\frac{P'}{P'_m}\right)^3 . \left(\tfrac{3}{2}\cos^2\mu - 1\right) + S'\left(\frac{P}{P_m}\right)^3 . \left(\tfrac{3}{2}\cos^2\sigma - 1\right)\right\}$$

$$+ \tfrac{3}{2}\sin 2\lambda\left\{ M'\left(\frac{P'}{P'_m}\right)^3 . \sin 2\mu \cos \overline{l - m} + S'\left(\frac{P}{P_m}\right)^3 . \sin 2\sigma . \cos \overline{l - s}\right\}$$

$$+ \tfrac{3}{2}\cos^2\lambda\left\{ M'\left(\frac{P'}{P'_m}\right)^3 . \cos^2\mu \cos 2\overline{l - m} + S'\left(\frac{P}{P_m}\right)\cos^2\mu . \cos 2\overline{l - s}\right\}$$

where λ denotes the latitude of the place where the tide is observed, μ and σ the declination of the moon and sun respectively, l the longitude of the place from a fixed meridian, m and s the right ascensions of the moon and sun, and P, P′, P_m, P'_m, and M′, S′, for our purpose, are constants. Now, this whole expression gives the height of the tide at any point and at any time; that is, it gives the height of a given particle of water on the surface of the ocean, but it does not give the height of that particle of water at different places at the same time. One thing it cannot do—make the given particle occupy more than one place at any one time!

The whole expression takes into account the position of the particle as acted on by the pressure of gravity under the moon and sun, whose declinations and right ascensions, etc., are changing from moment to moment, but it takes into account but one position of the particle at any one particular moment. When I am told that line 1 gives a fortnightly tide and a half-yearly tide, that line 2 gives a diurnal tide, and line 3 two tides, or the semi-diurnal tides, I am willing to accept the statements, if it be clearly understood that this is but a convenient mode of expression, and that we are not really speaking of four tides, but of one tide, and of four components of that one tide! When I find these components spoken of and treated as if they were distinct and separate tides, possessing different velocities and following the transit of the moon at any place at a variable interval, I return to my conception of the whole general expression as giving the height of one particle of water above mean level, or its depression below it at a distinct moment of time, and I say such a mode of speaking as I object to is incorrect and misleading, giving rise to grave misconceptions. That the different lines of expression cannot be absolutely set apart from the whole and devoted to different so-called tides, will be plain from Sir George Airy's own analysis; *e.g.*, line 1, we are told, gives a fortnightly tide which vanishes at places where the sine of the latitude $= \frac{1}{\sqrt{3}}$, for then the value of the first factor $(1 - \frac{3}{2}\sin^2\lambda)$ vanishes. Airy's words are, "These tides do not exist for places at which the sine of the latitude $= \sqrt{\frac{1}{3}}$." See what curious results that leads us to. It means that at places on lat. 35° 16′ there will be mean level of water under the moon from the "fortnightly" tide, while from that parallel

to the poles there will be a depression, and this quite independently of the moon's declination. The moon is not always on the equator; sometimes she is 29° N. of it, and again there are times when she is 29° S. of it. Can it be that this difference of 58° in the declination of the moon will make no difference as to the parallel at which the "fortnightly" tide vanishes? Even if the moon were always on the equator the tide would cause an elevation of the water up to the parallel of 54° 44′, or the parallel at which $\cos^2\lambda = \frac{1}{3}$, and thus the fortnightly tide cannot vanish at lat. 35° 16′. At 35° 16′, when the moon is on the equator, the value of line 1 of the general expression certainly vanishes, but the fortnightly tide does not! All three lines of the general expression contain either the sine or cosine of μ, and therefore all three have to do with the fortnightly tide. When the moon is on the equator the value of line 2 vanishes for all latitudes, but line 3 does not; and at the place for which line 1 gives mean level, line 3 gives an elevation corresponding to the constants of the expression multiplied by 1, or half the greatest possible tide. Even at 54° 44′ from the equator line 3 gives a tide whose elevation is to be considered as equivalent to the constants multiplied by $\frac{1}{2}$; but as line 1 now gives a co-efficient of $-\frac{1}{2}$, the lines balance each other, and there is mean level of water indicated by the combination of the two. How, then, is it possible to speak of the fortnightly tide as vanishing at 35° 16′?

But, further, when the moon's declination is greatest the vanishing-point is of course still further north or south. It is then mean level, or the fortnightly tide vanishes at the parallel of 83° 44′ N. or S. according as the declination is north or south, and so the fortnightly tide, as far as it is a real movement of the tidal spheroid, ignores completely the limitation of the astronomer to lat. 35° 16′. The truth is that when the moon stands over the parallel of 29° N. or S., the "equator" of the tidal spheroid is inclined to the earth's equator at an angle of 29° The axis of the tidal spheroid is inclined to the axis of rotation at the same angle, and the angle (54° 44′) at which the fortnightly tide will vanish must be measured from the tidal equator and not from the earth's. The formula of the general expression takes no notice of that, for what is lost to the height of the particle of water by one line is compensated for by the others, the whole expression being one, and the tide it gives one. To treat the expression as capable of being allotted, different lines to different tides, would lead us to emulate the attempt of the old lady who would fain sweep out the tide with a mop; we should be found attempting the feat with a line of a formula.

In fine, if the phrase "fortnightly tide" means the fortnightly movement of the tidal summit towards and from either pole—and if it does not mean that, I don't see any real meaning it can have—it cannot vanish, when the moon is on the equator, till we come to the latitude, the cosine of which, and not the sine, is $\frac{1}{\sqrt{3}}$. When the moon is at greatest declination point north or south, the tide will vanish at 83° 44′ N. or S., and 25° 44′ S. or N. At no time can the fortnightly elevation vanish at 35° 16′, as Airy states. Line 1 vanishes, that is all.

Then, as to line 2. This introduces the longitude of the place as well as the latitude, and also right ascensions as well as declinations. As cos $l-m$, cos $l-s$, go through all their values once in a rotation, and as the values of the cosines are equal, but of opposite signs, when $l-m$, $l-s$, have changed from 0° to 180°, it follows the line will give a difference in the value of co-efficients for the tide under the luminaries and opposite *on the same parallel.* This line has nothing to do with the difference in the tides at the points under the luminaries and opposite to them, *i.e.*, opposite along the lines joining centres of earth and luminaries. The value of the line is greatest when $l-m$, $l-s=0$, *i.e.*, under the luminaries; and when the earth has rotated through 180°, the value of the line is greatest negatively. This line, therefore, goes to increase the tide under the luminaries, and to diminish it at places in the same parallel 180° away. There is no difference naturally along the equator, and no difference, *i.e.*, given by this line, at the pole. That is, the value of line 2 vanishes at equator and poles. There can also—as a moment's consideration will show, when the luminaries are on the equator—be no difference in the tides along any parallel of latitude whatever. That is, the value of the line vanishes for every place on the earth when the luminaries are on the equator. This can also be seen at once from the line itself, for then sine 2μ, sine 2σ each $= 0$. This difference in the value of the tide along each parallel is what astronomers have called the "diurnal tide," to which they have also given a velocity of its own, and which is spoken of as following the transit of the moon at a variable interval. I think I may say all the astronomers agree in considering the diurnal tide to be in one place, or at one time, before the semi-diurnal, while at another it may be from anything up to five hours behind it. The line, according to my view, gives the difference in elevation of one semi-diurnal tide over the other at any place, the tide directly under the moon being raised at any place, and that opposite the moon along the same parallel depressed, the differential elevation and depression depending upon the declinations of luminaries as well as on the latitude of the place.

Laplace, it will be remembered, found that if the depth of the sea were uniform there would be no diurnal tide, for the expression supposed to give its elevation, absolutely, in such a case, vanished! This "most unexpected and most remarkable result" has been accepted by astronomers, and has even been extended by recent and distinguished writers.

I now proceed to show you graphically that, though there is no such thing as a separate diurnal tide, diurnal difference of two successive semi-diurnal tides there must be, and that, however expressions may vanish, the tide does not.

Let EQ in Fig. 1 be the earth's equator, PP′ the earth's axis of rotation, and MH the moon's direction. Supposing there is high water at H, there will also be high water at H′, and LW will represent the position of the middle of the band of depressed water; any place, that is, along the line LW will be in lowest water. At V and V′ there will be at the same moment a moderate high water but not nearly so high a tide as at H and H′, it being understood too that the tide at H′ will not be quite so high

as that at H. As the earth rotates on PP′ every place on the parallels HV, H V′ will, during the lunar day, successively occupy the position with reference to the moon held in the diagram by H and H′ respectively. When any place is at H or H′ it is in highest water. When it is crossing the line LW or the continuation of the hemicircle LW on the side of the earth invisible in the diagram, it is in absolutely lowest water. When the place has rotated from H or H′ to V or V′ it will be in modified high

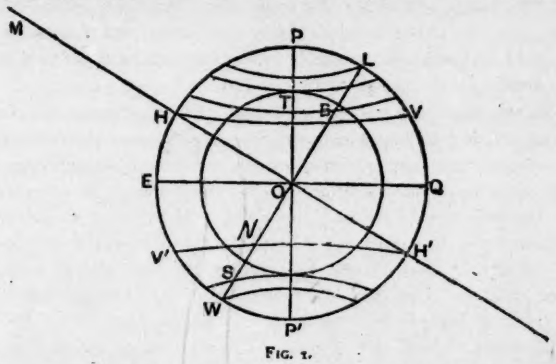

FIG. 1.

water. It will thus, during the lunar day, have passed twice through low water, once through highest water, and once through the modified high water. For any place on the equator there will be no diurnal difference except the very slight one owing to the high water at H′ not being quite so high as that at H, and should the moon be over the equator, and so EH or the moon's declination vanish, it is plain that the diurnal difference will also vanish at all places. The two semi-diurnal tides will then be equal all over the world, or the difference will be so small—being merely that due to the tide opposite the moon through the centre of the earth being slightly less than the tide immediately under the moon—that it may be neglected. On the other hand, it is plain that while the moon's declination is as given in the diagram the elevation of the water at H and V cannot be the same, nor can the elevation at V′ be equal to that at H′. It is also evident that, since the tide at H is higher than that at H′, and consequently the tide at V′ higher than that at V, the diurnal difference at H and V will be greater than that of H′ and V′, and thus it is plain that diurnal difference is most marked when the latitude of the place, on a true-tide bearing sea, and the declination of the moon are of the same denomination.

This theoretic result will be seen to be exactly confirmed, later on, by an especially interesting fact of observation. For the present it is sufficient for me if I have satisfactorily shown that there must be diurnal difference of tides at certain times and places notwithstanding any disappearance of parts of mathematical expressions.

To pass on, line 3 will show us, as line 1 did, that it is impossible to consider either line alone as giving a separate tide. Both lines have factors due to the latitude of the place where the tide is observed and to

the declinations of the luminaries, while line 3 alone has regard to the distance of the place from the luminaries in the factor cos 2 $(l-m)$, etc. As this factor goes through all its values twice in each rotation, and is greatest positively twice and greatest negatively twice, the line gives us the increase and decrease in elevation of the semi-lunar tide as due to the distance of the place east or west of the moon and sun. Under the luminary and along the great circle passing under the luminary line 3 alone has any value, just as 90° N. or S. of the luminary, line 1 alone has any value. At all other places all three lines must enter into our calculations for the elevation of the tide. No line can be separated from the others as giving an independent tide.

Let me repeat again the obvious truth that whatever influence each component of the tide may have upon the elevation of the particle whose position we are considering, not all the components together can make it occupy more than one position at the same time. It seems nothing short of impertinence to say so; but when I find that great philosophers have been induced to search for a diurnal tide as something to be found separate from the semi-diurnal tide under the luminaries, and when I remember that so great a mathematician as Sir George Airy has said, "These tides of long period have not yet been noted," that is, to use a slang expression, "spotted," and when I know that all attempt to "spot" them must be, in the nature of things, for ever vain, I can only set down the origin of the idea of these mythical tides to an extraordinary misinterpretation of a formula—a formula in itself beautiful and true!

"These tides of long period have never been noted"? No, and the tide of shorter period (the diurnal) has never been noted, though something else has in its place. It is not only in Sir George Airy's treatise on the equilibrium theory, but also through Laplace's theory, and through the wave theory the same mythic hunt occurs.

What wonder that, when the philosophers find their "diurnal tide," they find it a fearful wild-fowl appearing where it should not, and unexpectedly diving and vanishing out of sight where it should be! In the history of modern science there is not such another instance of the hunt after, and successful capture of the non-existent!

But I wish on this point to avoid being misunderstood.

It is not to the separate calculation of the component forces that go to raise a tide I see any objection; it is to thinking and speaking of these components as giving separate tides, which can be "noted" and measured and timed as separate entities, I consider serious objection may well be made. It is to a separate diurnal, a separate fortnightly, a separate half-yearly tide, I object, and it is of such tides, some of them "noted," and others "not yet noted," I deny the existence.

But, to return, this "diurnal tide" theoretically vanished at the poles and also at the equator; moreover, it also vanished for all latitudes when the sun and moon were on, or very near, the equator, for then $\sigma = \mu = 0$, and line 2 of the general expression vanishes. A very will-o'-the-wisp of a tide. But this tide, when found, refused to perform the

Hari-khari, and clung to its life with steadfast disregard for the calculations of the theorists.

It turns out there was no such tide, and there never could have been such a tide. Its story is like a chapter out of "Alice in Wonderland." It existed only in the imagination of the astronomers, who mistook another and quite a different movement of tidal water for it, and its supposed "abnormal" conduct is found to be the regular pulsation of a true tide which can be seen to be as true to its place and time as the sun and moon themselves. Before the great tide at Brest, and following it at Southampton, upsetting every rule at Petropavlofsk, surging about the equator, where it never should have been, what wonder even a hypothesis failed to account for its vagaries, while all the time, if we had only known it, this was an orderly and respectable movement, quite "constitutional" in every agitation!

It is time to inform ourselves as to the effect of line 2 of the general expression upon the calculated elevation of the tide along the upper and under meridians of the moon. We have already seen that this line loses all value for places at the equator and also for the poles; and further, we have found it also vanishes from the calculation for the tide of each luminary when the luminary is on the equator. Its influence will therefore be greatest about middle latitudes; and as its value depends partly upon the magnitude of μ and σ, or the declinations of the luminaries, increasing or decreasing as the declinations increase or decrease, the effect of the line will be greatest where these are greatest for the year, or at the solstitial full and new moons, and especially near the solstices of those years in which the moon's declination is at the maximum 29°. Let us then see the effect of the line upon the calculation for the lunar tide for such a year, at spring, at a place on the 45th parallel, both directly under the moon and also when the place has rotated through 180° from the moon. Here $\lambda = 45°$ and $\sin \mu = \frac{2}{5}$.

The line is $\frac{3}{2} \sin 2\lambda \left\{ M' \left(\frac{P'}{P'_m} \right)^3 (\sin 2\mu \cdot \cos \overline{l-m}) \right\}$, and becomes $\pm 6 \cdot \frac{\sqrt{21}}{25} \left\{ M' \left(\frac{P'}{P'_m} \right)^3 \right\}$, the positive sign being that for the tide on the upper meridian, and the negative sign that for the lower meridian—the change of sign being due to the factor $\cos l - m$, which for the point under the moon $= +1$, and for that 180° away, -1. The line, then, in such a year, adds greatly to the elevation calculable for spring tide at a place on the 45th parallel when it is on the upper meridian, and diminishes greatly the amount of elevation when the place is on the lower meridian. There is, in short, the maximum diurnal difference of tidal elevation at spring tides during such periods of greatest declination, especially—if I may put it so—at solstitial springs. But even during such a period, the *neap* tides will have but a slight diurnal difference—only that due to the sun's declination, which will be scarcely appreciable. It may be pointed out here, that very many of the notes in the Admiralty Tide Tables bearing on the matter of the amount of

difference between the heights of the two semi-diurnal tides, become quite unnecessary in the light of the preceding paragraph.

To give one example out of very many—when we are told that near the solstices one of the semi-diurnal spring tides of Sydney is little more than half the height of the other, we can see at once that this must be so; it is but what might on my view have been certainly predicted. Note also that the statement in the Tables—that in June and July it is the night tides that are higher, while the reverse is the case in December and January, when the day tides are the higher—is exactly in accordance with my view, and, in fact, may be considered on that view redundant! One has but to glance at the diagram to see that during the Northern summer, when the sun is near M, and the highest water at either new or full moon is at H′ (southern hemisphere), H′, being opposite the sun, has its highest water at night. When H′ has rotated to V′, the place will be on the meridian of the sun, or near it, and therefore the modified high water at V′ will be a day tide.

I have taken this instance of the Sydney spring tide at haphazard from the Tide Tables, and any reader of the Tables will see numerous instances of the same sort. If the reader have adopted the view I am urging on him, all such notes will be redundant for him, as he will be able himself to predict with certainty and without hesitation the facts of which it has been hitherto thought necessary to make a special note.

I may be permitted again to point to this agreement of my theory with fact, and to say that here we have a perfectly undesigned coincidence. I had not seen the Tide Tables till after I had drawn the diagram to which I have referred. It is only that the "fact of observation" jumps with my theoretic result: there is no need of any hypothesis, fanciful or otherwise, to bring about a reconciliation of the two. We must be on our guard, however, lest we should suppose that the state of things mentioned above will always exist. During the periods when the moon's declination cannot be greater than 17° or 18°, the diurnal difference even of spring tides will not be nearly so great as during periods of maximum declination.

One is led to believe that some of the apparent inconsistencies in the behaviour of the tides at places on the same ocean and near the same latitude may be merely apparent and due to the fact that the measurements were taken at the different places at different periods of the cycle of the sidereal revolution of the moon's nodes.

Suppose, for instance, that a series of measurements of the tides were made at the port of Sydney during a year in which the moon's declination reached 29°, and then that during a year in which the declination was never much more than 17°, the diurnal difference of spring tides in the former set of measurements would be much more marked than that of the measurements made during the latter period. Should the measurements be made at Sydney during a period of maximum declination, and a similar set of measurements be made at another port about the same latitude, and in the same ocean (say at Parengarenga Harbour, North Island, New Zealand), during a period of minimum declination, a

very different set of phenomena would be recorded in each case, and should such measurements get into the Tide Tables we should have a supposed inconsistency to unravel.

IV.—Effect of Diurnal Difference.

Let me now continue the discussion of the diurnal difference of the semi-diurnal tides at the same place. It appears that the effect of line 2 of the general expression will be to raise the tide of a place while it is on the meridian of the luminary, and to depress the tide when the place is 180° from the luminary. The tide under the luminary, that is, on its meridian, will be, except when the luminary is on the equator, higher than the tide on the opposite side of the earth along the parallel of the place where the tide is measured, and the difference in elevation of the tide at a place situated in certain latitudes will be so great that it may, and sometimes must, occur that there will be but one tide in the lunar day. A high water, that is, on the meridian of the moon and low water opposite to the moon. This seems a surprising result to derive from the formula, since we have been accustomed to think that if there is a tide at any place there should, or rather, must, be a tide at the opposite side of the earth. The apparent contradiction is due to a loose use of the term "opposite." At one time we use the word to express the position of a place opposite through the centre of the earth, and that is the correct use of the term; but again we use the word "opposite" to signify the position of a place 180° away from another along the same parallel of latitude. Now, although there will always be tides under the moon and opposite the moon, through the centre of the earth, whose difference of elevation will be but that due to difference of parallax at the two places, it is quite different as to the tides on the upper meridian of the moon, and on the lower meridian at the same latitude.

The accompanying diagram will best explain the apparent paradox, and with that certain other difficulties as to the movement of the so-called "diurnal tide" will also vanish.

Let EPQP′ be meridian under moon. Let moon's directions be in HM, at greatest declination; let EQ be the equator, PP′ the axis of the earth's rotation. Then LW will be half of the great circle of lowest water, and L and W will be at 61° N. and S. lat. respectively. On my principles there will be highest water at the two points HH′. Draw the parallels LR, WD. Then R and D will be each 32° only from highest water, while L and W are 90° from highest water, *i.e.*, in absolutely low water. Now, let the earth be supposed to turn on PP′ from Q towards E, and the place at L in the diagram will have reached the position at first occupied by R, in some 12⅓ hours. Thus passing from lowest tide to highest, but in 12⅓, not in 6⅙ hours. During the next 12⅓ hours the place will have got back again to low water, and will thus have had absolutely but one high and one low water in the lunar day. It is evident, then, that no place situated on the parallels RL and DW can have more than one true tide in the lunar day, when the moon's declination is greatest either north or south. Places near these parallels will have

practically but a single daily tide. Now, if we look at an atlas or a terrestrial globe, we shall see at a glance the quite satisfactory explanation of the "most remarkable tides" of Sitki Island and Petropavlofsk. Sitki Island lies in north latitude 57°, and is therefore very close to the

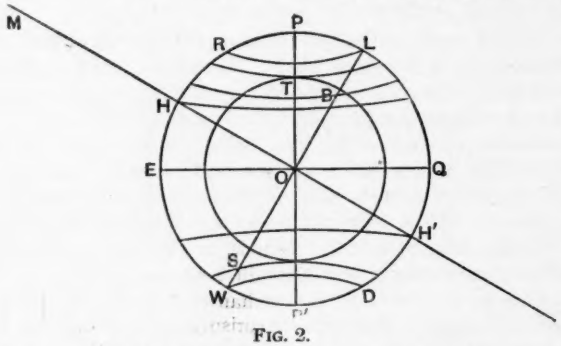

FIG. 2.

line RL; Petropavlofsk is in north latitude 54°, and therefore for both places there can be high water but once in the lunar day.

At first sight one would be disposed to say, "If these places have high water when on the meridian of the moon, they must also have high water when 180° away, for that is to be opposite the moon!" The diagram, however, shows where the fallacy lies, and the tides of Petropavlofsk cease to be "most remarkable" or "abnormal"! They are seen to be necessary and normal. Now, here was a peculiarity of the tides of these places in the North Pacific, a peculiarity which remains to this day inexplicable if it be supposed that the true tide is not under the moon; whereas, once it is understood that the greater axis of the tidal spheroid would normally lie in the direction of the moon, the tides are seen to be not merely possible but absolutely necessary!

A striking part of this supposed discovery of mine is that I was not thinking at all of Petropavlofsk when I worked it out. I was merely looking for the general results of my theory, and when I found it led me to the conclusion that at places near the parallel of 61° N. and S. there would be at certain times but one tide in the day I almost gave up the inquiry in disgust. I had never heard that places existed where there was but one tide in the day; but when I read that Whewell had found such places, and that they were just where I wanted them, whereas, hitherto, they had been a standing puzzle, I could scarcely avoid looking upon them as strongly, though on my part quite unexpectedly, confirming the view I had, on totally different grounds, taken. It is here as in so many other instances I have given or shall adduce; the theory was not set up to account for the facts, which were indeed unknown to me, but the facts, as I discover them, fall into their due place, and no additional hypothesis is required.

One thing at least seems clear: on my view, we must cease to speak of the peculiar tides of Petropavlofsk and Sitki as abnormal, for they are

but "peculiar" or "remarkable" in the same sense as an eclipse is a peculiar or remarkable event. While men remained in ignorance of the cause of an eclipse, no doubt that phenomenon was considered "most remarkable." Now we have ceased to think or speak of such an occurrence in that way. Thus also we shall cease to speak of these tides as peculiar, remarkable, or abnormal when we shall have learned their cause and recognised that they are the regular and orderly effects of constant, universal law.

V.—Additional Concordances.

Having already explained several of the irregularities and abnormalities of the tides, I shall now go on to show how other "inexplicable" anomalies also vanish when viewed from the standpoint I have taken, and I hope to do for these "abnormal tides" what has been done in such cases as the most remarkable tides of Petropavlofsk and the "too previous" diurnal of Brest.

A noteworthy instance of the concordance of theory with fact is given by the complicated tides of California (Lower), for which the editors of the Admiralty Tide Tables consider the following explanation necessary. I give the note in full. "The tides on these coasts are of so complicated a character that the following general explanation is considered necessary: There are generally in each 24 hours, or rather, in each lunar day of 24 hrs. 50 min., two high and two low waters, which are unequal in height and in time in proportion to the moon's declination, differing most from each other when the moon's declination is greatest, and least when the moon is on the equator. The high and low waters generally follow each other thus: starting from the lowest low water, the tide rises to the lower of the two high waters (sometimes improperly called 'half-tide'), then falls slightly to a low water (which is sometimes merely indicated by a long stand); then rises to the highest high water, whence it falls again to the lowest low water" (Admiralty Tide Tables for 1898, p. 207). Here we have indeed an apparently extraordinary state of things! And yet the facts so recorded fall into their place in my scheme as the pieces of a child's puzzle map do.

All that is wanted in order to see the necessity for this succession of lowest low water, slight high water, very slight fall or long stand, highest high water and then lowest low water again, is an atlas map of the world. On opening the map the necessity for this exact succession—that is, my theory being understood—is so obvious, that if I had not seen the note, I could have predicted it with confidence.

I can most easily give the explanation of these "peculiar" Californian tides with the aid of a diagram representing the position of the regions treated of, under the moon at the time of the luminaries' greatest declination. We may leave the influence of the sun out for the present, merely stating that as his declination increases, his tide will but accentuate the "peculiarities" noted. Let, then, MHH' represent the moon's direction, PP' the earth's axis of rotation, EQ the equator, and LW the circle of greatest depression of water. The line HV will be the parallel

of latitude passing over the middle of the region treated of. Now, the atlas gives the Pacific as having here a breadth of some 120°; the remaining 240° of the circuit may be taken as land, as the Atlantic will have, as far as these tides go, no influence whatever. Starting, as the note does, with the coast-line of California in its lowest water, we shall have it at B, the intersection of HV and LW; before it (eastwards) 240° of land, behind it (westwards) 120° of water. When the point we are considering on the Californian coast is in lowest water, the apex of the tidal cone would be in an ideal world at H, where, on our earth, are the eastern coasts of Asia. Thus there will lie an expanse of water all along the parallel from H to B. The "differential attraction" of the moon will therefore have its full force in producing a depression at B, and the water there will be the lowest possible. As the point treated of rotates towards V, it passes into the region of high water, but as V is

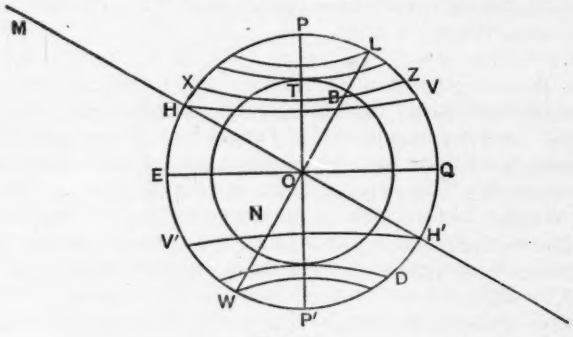

FIG 3.

some 58° from the highest water at H', the high water there (at V) will be but relative, and actually below mean level. Our point is at what the note states is "improperly called half-tide." As the point rotates further, it comes again into the region of lowest water. But mark the difference! When last at lowest water it had continuous sea between it and the point under the moon, the water at our point was then under the full squeeze of the pressure force, or, in popular language, it was being drawn towards the moon with full attraction.

But now between it and the moon lies a region of solid land. There is no pressure, at the moment it is crossing the continuation of the semi-circle LW, towards the moon. True, there is pressure towards the high water at V, but, as I have shown, the high water at V is below mean level, and therefore, in the progress of our point on the Californian coast from V to low water, there is but very little increase of pressure, and the water "falls very slightly to a low water which is sometimes merely indicated by a long stand"!

Naturally, and especially so, when the sun's declination is great, and so his influence goes to accentuate that of the moon! Thus we see that these abnormal Californian tides are but another instance of the strictest obedience to law. Every phase of the tidal movement, every

slightest variation of rise and fall, is just what it might be expected to be. Now notice the remarkable contrast between the order of succession of low and high waters in the extract from the Tide Tables, given above, and the following note copied from the Tables, p. 199. The note refers to the tides on the *east* Australian coast, and is as follows:—"From April to October the night tides are higher than the day tides, and the reverse for the rest of the year. The usual sequence of the tides is from the lower low water to the higher high water."

As to the first sentence of the note, you have already seen that it describes a sheer necessity, and is quite redundant. But the second sentence? On the *west* coast of California the sequence is from the *lowest* low water to *lower* high water; on the *east* coast of Australia from lower low water to higher high water. And the reason? When the east coast of Australia is at the point N of the diagram, the region of low water, from the coast-line right away to highest water at H′, there is a clear stretch of sea and full depressing forces acting at N, which moves on to the region of high water, and then again to the region of low water at the back of N. But now the continent of Australia is behind it. There is no pull or pressure of the water to H′, only to the modified high water at V. This low water will, therefore, not be so low as the previous low water. The succession will, therefore, be as stated in the Tables, and the difference in the order of succession from the order of succession of the Californian tides is seen to be necessary.[1] A curiously exact concordance between a recently noticed fact of observation and my theory deserves our attention, while we are on the subject of Australian tides.

Captain Goalen, to whose practical knowledge of the tides I am much indebted, informed me that, though the fact was not yet in the books, the tide at Hobart Town disappeared altogether at certain times, and almost, though not quite, vanished on days a fortnight earlier and a fortnight later than the day of its total disappearance. It turned out that the smaller of the two semi-diurnal tides had disappeared in 1893 when the moon's declination was nearly maximum—that is, just when it had a chance of disappearing—but the total evanescence of the tide occurred when the declination was South! When declination was North the tide was very much reduced, but did not quite disappear. I have already shown how the diurnal difference should be greatest when the latitude of the place and declination were of the same denomination, but I scarcely expected so curiously exact a corroboration as this vanishing tide of Hobart Town gives.

It must be noticed that the tide of Hobart Town is a small one. When declination is great and South the smaller of the two daily tides fails to get up through the deep bay in which the port stands.

[1] This peculiar succession of tides at California and Australia is inexplicable on the theory that the tide is normally 90° behind the moon. On that view it must remain "abnormal"! It is with confidence as to the result I challenge upholders of the accepted theory to explain this succession.—J. H. S. M.

There is yet another peculiarity of the tides, noticed at places in high latitudes, which is well deserving of our attention. Indeed, I admit that, so exceptional is the fact noted, in our experience, I had almost spoken of it as "remarkable."

I allude to such tide as those of "Burrard's inlet," latitude 53° N. The Tide Tables give, on p. 208, the following note on these tides. It is exceptionally interesting, and I therefore quote it *in extenso*. "From September to March the day tides are the highest; the reverse occurs during the other months. The diurnal inequality is great, causing apparently but one tide in the 24 hours on many days. The tide has the peculiarity of rising to nearly the same level at the higher high waters, *whether it be springs or neaps*, whereas the level of low water varies in the usual manner.

As for the diurnal difference being great and causing but one tide in the day, after my experience of the tides of Sitki and Petropavlofsk there was really nothing to explain. But that spring and neap tides should be equal anywhere was, I confess, a surprise. On reading the note, I set myself the following problem:—"To find the proportionate values of spring and neap tides along parallel $\cos^{-1}\frac{1}{\sqrt{3}}$ N. lat. at summer solstice and at equinox."

Solution: Take $OT=\cos^{-1}\frac{1}{\sqrt{3}}$, and describe a circle with centre O and radius OT. This will be circle of mean level of water at equinox. Draw XZ, a tangent at T. ZX will represent the parallel 54° 44′ from equator. Let MHH′ be the direction of the moon at greatest declination near June 21st (new moon). The sun will be within 5° of M, so that MHH′ may be taken as roughly giving the direction of both. Then the highest (spring) tide at solstice will be at H, and one not quite so high

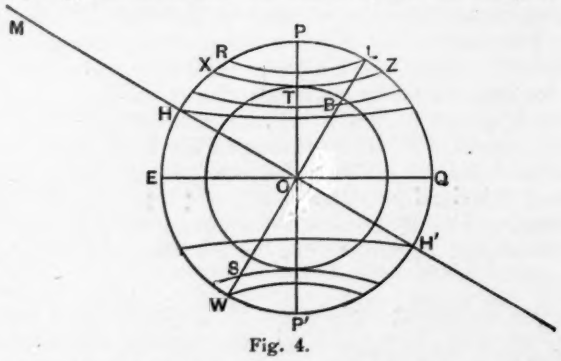

Fig. 4.

will be at H′. LW will be the line of lowest water at this date, and RL the parallel in which it is impossible there can be more than one true tide in the day. X and Z are each 54° 44′ from the equator, and therefore, under the conditions I have stated, X is 26° from the apex of the tidal cone of the day tide at H, while Z is 84° from the high water at H′,

and therefore in almost lowest possible water. It is clear that at this new moon the day tide will be large at X, while that at Z (the night tide) practically vanishes. At most, the elevation at Z can be but little above lowest water. There will thus be at the solstitial new moon in a year of great declination a great diurnal difference in the elevation of the day and night tides.

Let us see what the neap tides will be.

A week after new moon that luminary will be over O on the equator, and her high water will vanish at T, which will have, as far as the moon is concerned, water at mean level. X and Z will both be in her low water. Plainly, the high water of this neap tide at T will be but relative, *i.e.*, as compared with the depression at X and Z, the circle PZQP'E now representing the line of moon's low water. But the depression at X will not be nearly so great as that at Z, for the influence of the sun still goes to raise the water at X, the sun having scarcely perceptibly moved southwards during the week. The two relative high waters—that at T, and that opposite T along the same parallel—will be nearly equal, but the depressions unequal. The high waters, being but relative, will be at this neap tide less than the spring day tide, and greater than the spring night tide. But the single tide along the parallel 54° 44′ has given place to two nearly equal but very small tides in the lunar day, with two unequal low waters.

Now let us see what the tides will be proportionately to one another, (spring and neap) at the autumnal equinox. About September 21st the sun will be over the equator at O, and the moon, at new moon, will be so near we may again take their directions as the same. The equinoctial spring tide will, therefore, be highest on the equator, and its elevation will vanish at T. From T to the pole there will be depression.

Thus at the equinoctial spring tide there can be no tide above mean level along the parallel XZ. There are two lowest waters, at X and at Z (lowest possible), and therefore a relative tide at T and opposite T, but *the highest water will not be above mean level.* So much as to the equinoctial spring tides along the parallel 54° 44′.

What of the neap equinoctial tides? A week before the equinoctial new moon, she was entering on her last quarter, and was 90° from the sun on the equator, and she occupied the same position as in the diagram, the sun being at this time practically over the equator. The moon was, therefore, producing her highest water at H, and high water—though of course not so high—at X, which is nearly 26° away from the apex of her tide. At Z the tide produced by the moon may be considered as practically at low water. The sun's tide almost vanishes along the circle through T, and the circle PZQP'E gives the lowest water of the same. The tide at X is, therefore, the moon's tide at a point 26° away from her, diminished by the depression produced by the sun's influence.

There will be, practically, then, but one high water along the parallel of 54° 44′ in the lunar day, but this high water will be higher than that of either of the semi-diurnal equinoctial spring tides. At the 50th parallel, north latitude, which passes over Vancouver Island, the neap (equinoctial)

tide will differ little in height from the spring tide, but there should be, practically, but one high water at neap, while there should be two equal tides at spring. This may seem to us (who are accustomed to tides from a latitude where at all seasons of the year the spring tides are greater than the neaps) a surprising result, but it appears a theoretically necessary one. If this be so, it is clear that the note I have quoted from page 208 of the Tide Tables describes the tides exactly, in every particular, as they should occur, and there is no puzzle nor any difficulty to explain. If, on the other hand, the view put forward in these pages be false, it must be considered a strange coincidence indeed that the theoretically necessary tides should agree so closely with the facts of observation. It will be seen that in this and other cases, the moon's declination has been taken as maximum, but it must be remembered that it is very seldom that this extreme declination can be even approached even at spring tide. There are years when the greatest declination of the moon will be of course very much less, and in every year there will be several months during which the declination at spring tide will range from 0° to 12° or 13°. When the declination is small, the tides will approach those of an equinox, and the smaller the declination at full and change of moon, the closer will be the approximation to the equinoctial tides. Equally, when the declination of the new or full moon is very great or very small, the tendency will be towards but one tide in the day. When the declination is great, I should, however, expect the tide to vanish at spring, and when the declination is very small it is one of the semi-diurnal neap tides that will disappear. No wonder that with no key to the system, or with a key that did not fit, people should have been puzzled, and completely at a loss to account for the tides of Burrard's inlets. With the key of my theory in one's hand there is no longer the slightest difficulty; there is no abnormality or irregularity.

Is this again but a casual concordance?

Again, the discovery of considerable tides at certain places in the Mediterranean—a discovery made in recent years—seems once more to form, at the same time, a puzzle on the received theory, and a concordance with the results obtained on the scheme advanced here.

It was till recently supposed that the tides in the Mediterranean were almost inappreciable, and it was considered impossible there could be anything but a very small tide there. If you will remember, the view adopted by me is, that every sea on the surface of the earth will have its own true tide; that where the sea is narrow, from east to west, this tide will be inappreciable, but the wider the sea, the more noticeable the tide. Further, that on a coast running north and south, across the course, that is, of the tide, the water will be swept back, and the tide retarded and raised. Now between the Syrian coast and the Gulf of Cabes the Mediterranean covers a space of 25°. At Cabes there is a line of coast running north and south, and along this coast a spring tide of some 6 feet has been measured (*vide* Tide Tables for 1898, p. 179).

It is abundantly clear that such a tide could not possibly be raised in the Mediterranean by any inflow through the narrow passage of the Strait of Gibraltar. And if we could bring ourselves to believe in such impossibility, it would pass the wit of man to account for the fact that it is not near Gibraltar, but many hundreds of miles away and round a corner, so to speak, on an east coast, that this tide is found. Surely here there is but one view possible. The tide is the true tide of the sea, piled up upon a coast running right across its track—a tide derived from this running up the Adriatic, and arriving at the extremity of that shallow gulf some nine or ten hours after the moon. The Mediterranean and the Adriatic teach the same lesson, on a small scale, that the Southern Ocean and the Atlantic do on a large one.

Are we not justified in saying so, or is this again to be reckoned as but a fortuitous and deceptive coincidence? Once more theory, at all events, finds itself in agreement with fact, and there is no need for a new hypothesis.

VI.—Concordances of Theory with the Predictions of the Tide Tables for British, etc., Ports.

On the supposition that the noticeable tides of the North Atlantic are not derived, but are the tides of that ocean uninfluenced by any other, it ought to follow that when the luminaries are highest over that sea the tides should also be highest, and when the declinations were greatest south, the North Atlantic tides should be diminished. But, in fact, it is the contrary that takes place! When the moon's declination is north and greatest, that is, when she is highest over the northern regions of the world, the tides of the North Atlantic are lower than when her declination is south. As the declination of the moon diminishes north, passes south and increases south, the tides of the North Atlantic increase in height.

It may be worth while to examine the change in the height of the northern tides as compared with changes of the moon's declination. We shall see how, when the tide should be high in the Southern Ocean, and when it is shown to be high by actual measurements, and when therefore it should not be so high, if it were a true tide, in the Northern Ocean, the tides of the North Atlantic are at their highest. The tide of the North Atlantic is highest when the declination of the moon is south, and lowest when the declination of the moon is north.

The port of Brest, lying as it does on the open Atlantic, and for which predictions are made in the Admiralty Tables, will afford important information; but the same lesson can be learned from Sligo, or indeed from any seaport of the British Islands.

Taking first the tide predictions for the month January of 1898, we find there will be full moon on the 8th, when the moon's declination is set down as 24° 20′ N. The tide on the afternoon (highest spring) of the 10th is put as 18 feet. Then the new moon occurs on January 22nd, declination being 18° 15′ S., and the height of the tide on the 23rd is

set down as 20 feet 1 inch. The new moon spring tides are, then, for this date, considerably higher than those of the full moon.

In June, on the other hand, the full-moon tides are given as exceeding those of the new moon, the highest new moon tide of June being but 17 feet, while that of the highest full-moon tide is 19 feet 6 inches. So that at one season of the year the tides of new moon are the highest, during the other season it is under the full moon the greatest tides are to be looked for. Of course in June the full-moon's declination is south and the new-moon's is north. And thus it will be found throughout the year: when the declination is greatest north, the tides of the North Atlantic are the least, whereas, if they were true tides, they should be greatest; and when the declination is greatest south, the tides of the North Atlantic are greatest, whereas they should then be lowest, *i.e.*, for spring tides. The tides at Cape Town are (naturally) high when the south declination is great, and lower when the north declination is great; but how are we to explain the fact that the tides of the North Atlantic conform to those of the Cape? By deriving the North Atlantic tides from the ocean that washes the Cape.

I have tried your patience too much, and, though far from having exhausted the coincidences, will conclude with an expression of gratitude for the exactitude of the information supplied by the Admiralty Tide Tables. Without the Tables I should have been very much "at sea." With the information supplied by them I have worked my way into port. I do not profess to be able to explain every fact of the tides, but I assert that no fact noted in the Tide Tables need puzzle even the "simple sailor."

Mr. G. H. DARWIN, LL.D., F.R.S.:—I wish to thank Mr. Moxly for his courtesy in forwarding me an advanced proof of his paper. It is so difficult to criticise a large subject such as the present one, that I fear I shall hardly be able to take full advantage of this early information. Whilst I find myself in profound disagreement with Mr. Moxly in his general conclusions, yet much of what he has said is true. It appears to me that he imputes to mathematicians many incorrect ideas, and then proceeds to demolish them. As far as I understand his investigation of tide-generating force, I think we agree perfectly. He objects, however, to the omission of the effects of the vertical component upon the ocean, whilst the mathematicians maintain that it is the horizontal component which is the important part. That component is at right angles to the direction of gravity. If we imagine a pendulum formed by a stone suspended by a string, it is clear that a horizontal force must deflect the pendulum. The horizontal tide-generating force is, however, very small, and the deflection of a pendulum is so minute that it has never yet been certainly measured. A suspended weight is, in effect, a level, for the cord must always hang perpendicularly to the surface of the water. If sufficient time be given, the water will assume a level perpendicular to the pendulum, however it may be deflected. The vertical component of the tide-generating force will only infinitesimally affect the level as due to the horizontal force. It is on that account that mathematicians set aside the vertical

NOTE.—Where in this paper the term "mean level" is used, the level at which the water would stand, were the sun and moon non-existent, is to be understood.

component of the tide-generating force. They admit its existence, but they say that if it were included the result would not be affected to any sensible degree. With regard to the equilibrium theory of the tides, it is hard to appreciate the justice of Sir George Airy's strictures on it. The theory forms, indeed, the foundation of all that has ever been discovered with respect to tides. Sir George Airy was, I think, arguing against those who attempt to use it to make actual tidal predictions, and he saw that this was not possible. It would seem then that Sir George Airy's remarks are directed precisely against such arguments as those of Mr. Moxly. He also is apparently compelled to surrender the equilibrium theory; for he considers the tides of the Atlantic to be largely due to a wave which moves northward from the Cape of Good Hope. But the theory is no longer one of equilibrium, when we are driven to refer to a wave which travels over a great ocean such as the Atlantic. Sir George Airy would certainly have admitted that the equilibrium theory, when properly used, was an absolutely necessary step towards the foundation of any satisfactory theory of the tides. It may be well to remark that the existence of land on the surface of the planet affects the equilibrium theory; and Lord Kelvin has shown, in Thomson and Tait's "Natural Philosophy," what connection is needed to allow for the fact that the ocean does not cover the whole of the earth. This correction is, however, of merely a speculative interest, and does not bring us nearer to the prediction of tides. Mr. Moxly then proceeded to attack the dynamical theory of the tides. He remarked that mathematicians find that low-water should occur under the moon, instead of the high-water as predicted by the equilibrium theory. But he is clearly not aware that Laplace proved that in high latitudes, near to the Poles, it should be high-water under the moon. Accordingly, the dynamical theory of the tides accords fairly with reality in regard to the Southern Pacific Ocean. I should not, however, be disposed to lay much stress upon the accordance between the correct dynamical theory and fact in this respect, because the dynamical theory is based upon the supposition that the earth is covered entirely by ocean, and the great promontories of Africa, South America, and Australia would so modify the oscillations of the whole ocean that we can feel no confidence that the result for a sea-covered planet will remain the same when the ocean is interrupted by continents. Mr. Moxly has referred to the figure of the moon, as affording evidence in favour of the equilibrium theory.[1] I would submit that it is impossible to determine the moon's figure by micrometric observations. Our knowledge of the moon's figure is derived from Laplace's discussion of the libration of the moon. The moon always presents the same face towards the earth, but, as she revolves in her orbit, she rocks or librates slightly. Laplace discussed the libration, and investigated the effect of the earth's attraction upon the moon. The amount of libration depends upon the distribution of the weights in the moon, and Laplace thus determined approximately the so-called principal moments of inertia in the moon's mass. From these evaluations it is possible to infer with a considerable degree of probability the diameter of the moon in the three directions. I conceive that there is no reason whatever to suppose that the invisible side of the moon is less protuberant than the visible side. If the generally received theory of the tides is incorrect, it should be impossible for us to provide accurate tidal predictions. I wish, then, to draw your attention to the degree of accuracy attained at Portsmouth; although, as I believe, these predictions might be much improved by the light of present knowledge. [The speaker then gave details of the accuracy attained by these predictions.] Mr. Moxly objects to the use of the term "diurnal tides." Every mathematician understands, however, that the term is merely used as a convenient manner of analysing our ideas, and that the diurnal tide does not exist by itself. It is, in fact, merely a figment for facilitating discussion. When I listen to a band, I say that I hear the flute, the trumpet,

[1] The argument does not bear on the applicability of that theory to oceanic tides on the earth. - G. H. D.

and the violin. But at any one moment there is only one sound-wave entering my ear. A single curve represents a full orchestra, but the listener picks out each instrument independently. Is it absurd of him to say that he then hears the trumpet or the flute? I certainly think not. Similarly in the discussion of the tides, the phenomenon is single, but we may pick out one portion of it and discuss it separately from the rest, whilst realising that it is really only a part of the whole.

Mr. A. G. GREENHILL, M.A., F.R.S. :—As Mr. Moxly indicated, I had the privilege of discussing this question with him on a previous occasion, so that I was able to follow his remarks with greater interest and attention. I gathered then that his chief point of dispute, his chief objection, appeared to be a criticism of Laplace's theorem concerning the evanescence of the diurnal tide. I must confess that I was not prepared to meet his objections at that time, because Laplace's works are amongst those hundred best books on mathematics which we all admire, but which we seldom find time to read. The criticisms which were levelled by Mr. Moxly at mathematicians and their methods would, I think, be deserved, if the mathematician contented himself with leaving his formulas in the algebraical state; because the analysis he employs would be equally applicable to the tides on other planets, say on Mars, for instance. The peculiar appearance of the canals on Mars may be due to the tides on the surface. The analysis is, however, universally applicable, provided the series we employ can be expanded in the same manner, provided the same methods of expansion are permissible. But in the case of the earth, and in the case of Laplace's theory concerning the diurnal tide, the conditions would be reversed if it were the case which a very slight alteration of the earth's surface might be able to bring about—that the mean depth of the ocean was something about 14 miles or more. In that case the tides on the surface of the earth would become enormously increased, and perhaps the surface of this earth would present to the observer on Mars something of the same appearance that we observe through our telescopes. To test Mr. Moxly's theory, the tides in mid-ocean must be observed, say on an isolated island, like Teneriffe, but as Newton says:—"Fluxus et refluxus in Insulis, quæ à littoribus longissime absunt, perexiguus esse solet." Newton uses the words "fluxus" and "refluxus" of the tides, and does not speak here of ascensus and descensus. I think Mr. Moxly has been discussing the tides entirely from the point of view of the ascensus and descensus; that is the landsman's point of view. I remember in Lord Kelvin's lecture, at Southampton, on the tides, he brought forward the fact that whereas on the charts you will find a place marked "very little tide here," the landsman will say the tide is very great, because of the rise and fall, and *vice versâ*. The tide in the sense of flux and reflux shows itself most where it makes its way over shallows and through straits, where the influence of the contour of the ground completely masks the leading causes considered by Mr. Moxly. If I may quote again from Newton:—"In Portubus quibusdam, ubi aqua cum impetu magno per loca vadosa, ad Sinus alternis vicibus implendos et evacuandos, influere et effluere cogitur, fluxus et refluxus debent esse solito majores, ubi ad Plymuthum"—and various places such as Chepstow and Mont St. Michel, which are cited by Newton. There is an extraordinary phenomenon of the bore, the *barre* or *mascaret* of the river Seine, and also a certain Chinese river, of which you, Sir, were so kind as to send me an account. I take it, it would be impossible to frame a general theory which would account for all these abnormal causes. We are indebted to Mr. Moxly for forcing us to a reconsideration of the leading causes of the tides. He treats the subject in the orthodox manner, if he will allow me to use the expression, that is to say, he treats the tides as due to the action of the sun and moon, not as a subject of disputation. Some two or three hundred years ago, we read in Anthony Wood's "Life and Times," it was a favourite subject for disputation in university schools concerning the tides, as to

whether they were due to the action of the sun or the moon. To the waterside and the coast population the tide is a more important division of time than the day or the hour, and the tide-table is more important than the calendar, so that to seafaring people the Hydrographer Royal plays a more important function than the Astronomer Royal does with us in regulating our clocks and watches; so that the subject of Mr. Moxly's lecture is of great importance in practical life.

Commander A. E. A. GRANT, R.N.:—I have a few practical questions which have been sent to me, with the request that I should put them to the lecturer; they came too late to be included in the lecture. The first question is, Why is the highest water at Hong-Kong sometimes three days after the full and change, and at other times there is much less retard of the tide? Another question is, How is it that at Albany Isles, North Australia, the highest water is frequently a day or more before the full and change? These places, Hong-Kong and Albany, are in the same ocean, and therefore the results should be the same. Another question is, Why does the tide at Hong-Kong ebb for seven hours and rise for but five hours? We are taught that the equinoctial tides are the greatest of all tides, and likewise the least of all tides: Why is the tide at Whampoa Docks 4 feet higher in June than in March? And why are the tides in March equal day and night, when at other seasons they are unequal?

Captain JAMES D. CURTIS, R.N.:—I confirm what was said about the Straits of Georgia. The tides there are such that no one can understand them.

The CHAIRMAN:—It was the Island of South Georgia that I think the ecturer mentioned.

Captain CURTIS:—Vancouver Island—no one can understand the tides there. At Comox the tides meet certainly about 6 miles below Cape Mudye; that is, about 20 miles from the Seymour Narrows. I think that is a most important thing now that there are a great many people going to Klondike, and steamers crowding there, and they have to take shelter under Point Menzies or Menzies Bay. They cannot go through Seymour Narrows unless it is slack water; no vessel can go through against the tide, as the vortices extend across the Narrows. I think it would be a good thing if the Government had tide-gauges at Victoria and at various points so as to get some indication of register of the tides, so as to index the tides regularly. I have had some experience there, having been resident one year there, in 1890. The Rev. J. H. Moxly's idea of the tide is quite within reason. I think it could be exemplified in a vessel to contain water and an oblate spheroid model to rotate therein. But he must accept the action of the moon and sun, as well explained in "Whitaker." No general knowledge appears to be known of the tide in the Straits of Gibraltar and the Bosphorous. A friend of mine, experimenting in a boat, drifted against the surface current in the Bos phorous. More might be said about the under-current at the Poles, as it is said the water passes from one sea to the other.

Captain J. WHITLY DIXON, R.N.:—I do not think from my practical knowledge the tidal theory can be reduced in any simple mathematical form. The main portions of it can be. think neither the theory of Newton nor Laplace, not even with the aid of the harmonic analysis of Professor Darwin, would give sufficient accuracy. It is generally said that it is better to give examples than a theory. I would first say I do not think they lay sufficient stress on the physical changes in the earth's surface. Again, in my own experience I have obtained the establishment of a port—does that alter, or does it not? For instance, in the Menai Straits tidal constants were ascertained by Staff-Commander Kerr, and again by myself when I was in temporary charge of the survey, and they certainly disagreed. Take the tidal constants between Chatham and Sheerness, where I have been employed surveying. My results disagreed with those of Captain

Bullock, and I find that more recent results disagree with mine; so that I think, speaking as a sailor, as far as we know, there is no theory which can foretell accurate tidal results, owing to our being unable to foretell atmospheric changes, etc. I am sorry Mr. Moxly has not told us what influence he thinks the sun exerts on the tides. Then, again, I should like to know what influence he thinks earthquakes have upon the tides. Anybody who was in South America in August, 1868, as I was when that great earthquake took place, would know that it resulted in what is called a tidal wave. Again, on the West Coast of Australia the eruption at Krakatoa exercised a distinct influence on the tides for some time. In a smaller degree, by means of magnetic instruments, we find there are always earth tremors of various degrees of intensity. I do not suppose they exercise a large amount of influence; but what amount of influence do you consider they have upon the tides? The method in which the tidal wave is transmitted over large portions of shallow ground will generate heat. This again, I think, will affect the atmosphere, and the atmosphere again affects the tides. I am only speaking of these things as incidental; I do not think they affect the main features of any tidal theory. I am glad that Mr. Moxly and Professor Darwin have had rather a knock at the late Astronomer Royal, because I have been reading his article on magnetism in the "Encyclopædia Metropolitana," and the moment he left the safe paths of mathematical theory and went into prophecy I found him very much adrift. I should like Mr. Moxly just to answer the question, To what extent he thinks the sun acts on our tides?[1]

The CHAIRMAN (Sir W. J. Wharton):—Before I ask Mr. Moxly to reply, I would just say a few words myself. Mr. Moxly has had a very good slash all round at everybody. I do not think he finds that anybody agrees with him, so far as I can understand. He has as much contempt for the giants of the past as he thinks Sir George Airy had for the equilibrium theory. In the course of it, although from one point of view he has been complimentary, from another he has made certain remarks about the Admiralty Tide Tables which I do not think I ought to let pass by without saying two words about them. He would have us omit all reference to what are generally known by the name of complicated or abnormal tides, that is to say, a tide not like those to which the British nation is accustomed in the British Islands, because he says it is perfectly easily calculated by his theory. I think he forgets that tide tables are published for the use of seamen. We have nothing whatever to do with theory. We do not care the least bit whether it is the equilibrium theory or the dynamical theory which is considered as being the ultimate and right cause of the tide. What we want to do, is to give to our brother seamen as much information about the tide as we can. Most of those remarks which he speaks about and calls redundant have been put in at my instance, and I have every intention of adding as many more as I possibly can. I just wanted to explain that to Mr. Moxly. It is quite impossible to follow Mr. Moxly through all his remarks; and besides, the really important part of the paper, the theory of the tides, has been dealt with by Professor Darwin and Professor Greenhill. But I should like to ask Mr. Moxly if he thinks he can calculate the complicated tides of the greater part of the world without the use of harmonic analysis. Harmonic analysis is merely a means which the mathematicians have put in our hands for unravelling this extreme complication of the tides. You may be able to say that a certain effect will take place at a certain time of the year from a simple theory. But an elaborate

[1] If it were possible to eliminate atmospheric disturbances, physical causes, and instrumental errors from tidal observations, I believe it would be found that a minute but systematic change took place in the mean tidal establishment of a port, depending, or rather governed, by the positions of the moon and sun, and in addition there is a minute but regular secular change in the mean tidal establishment of a port.—J. W. D.

prediction, such as is necessary for any practical purposes, can, so far as I know, only be made by the use of harmonic analysis. For that purpose it is necessary to assume a large number of certain waves that are merely assumptions. I should like Mr. Moxly to answer that question, Can he predict a tide at a place like Aden or Hong-Kong, or anywhere else, where there are very large seasonal weekly, and almost hourly differences? I will now ask Mr. Moxly to reply.

The Rev. J. H. S. MOXLY, in reply, said:—I never had more pleasure in replying to a criticism, for I do not think that which I have to meet is worth much. The points on which I challenge contradiction have been left untouched. First, may I take up the remarks of the Chairman? Fault is found with the way in which I spoke of the Tide Tables: it is said I am contemning them. Nothing was further from my intention. I intended to compliment them, and to say how useful they had been to me. I could not have proved my case, as I have, if I had not had the extremely accurate information which the Tables afforded me. I never dreamed of blaming the Hydrographer for giving that information, nor do I see how I can have been understood as doing so. With only the accepted theory such information was absolutely necessary. The facts recorded are facts, though "anomalous" and inexplicable. But accept my principles, and these special notices become unnecessary. For instance, to tell a sailor, who had adopted my view, on page after page, that in the months of June and July the day tides will be higher at ports in the northern hemisphere and the night tides higher at ports in the southern hemisphere, is to give him a piece of information which he no more requires than he does such information as that in June and July the days are longer in the northern hemisphere and the nights are longer in the southern; and the reverse in December and January. That is what I mean. Accept my principles, and the special notices, so necessary now, may disappear from the Tables. As for harmonic analysis, it would be going quite outside my present province to discuss that. It is true I do not myself believe in the *necessity* for its use, but as I have said in my paper it is not to the calculation of separate expressions I object, but to the calculation and *measurement of separate tides!* But harmonic analysis has not done very much for people, after all. It has not told us so much about the tides of Burrard's Inlet, for instance, as I can see without it, and I do not think it ever will. The accepted theory tells us nothing about these tides. They are absolutely inexplicable by it and contradictory to it. If the great mathematicians knew about these tides—their causes and the necessity that they should be exactly what they are—then they have dissembled their knowledge with remarkable success. They have never drawn a diagram like mine, or shown how such tides must occur. And these questions you have heard asked, show that navigators—the men who are most deeply interested in these matters—are still completely puzzled. How is it that if these gentlemen can explain these tides, they should still remain puzzles to the men whose lives are spent in trying to understand them? Now I will give you my explanation of the puzzles propounded by Commander Grant:—First, "How is it that *sometimes* the highest spring tide at Hong-Kong occurs three days after full and change of moon"? Answer: Because it cannot help itself! Open the Tide Tables and you will see there was full moon on April 6th last. Her declination on that day was 9°. The apex of the tidal cone then passed on April 6th over places 9° from the equator. On the next day declination was 5° greater and the apex of the tidal cone of the northern hemisphere was 5° farther north; and so on till on April 9th the moon was above 23° from the equator, and Hong-Kong lay in the path of the very apex of the tide. The tide of the 9th was not so high under the moon as the tide of the 6th was, but the highest point of the tide of the 6th was 14° (nearly 1,000 miles) away from Hong-Kong, whereas the summit of the tidal cone of the 9th passed over that place; and so a del..y of highest spring tide for three days would occur at Hong-Kong for the full moon of April 6th. Is this common-sense? Is there really any anomaly here? Now take the complementary question, "Why

at Albany Island, in the same sea, is the highest spring tide often *before* full and change of the moon by a day or two?" Surely here again, if the theorists knew all about the matter, their knowledge has been successfully concealed! How is it that an officer, who says "tides are a great part of my business," writes from the far-off China sea, and asks if I can tell him any reason why this tide should occur as it does, and also asks if there is any natural explanation of the occurrence of a single tide in the day at Vancouver? If these great men knew the reason for the existence of these "anomalous" tides, why have they not given this information to those whom it concerned and removed these puzzles out of their way? Now, you have heard much of oscillations. The theory is, that just as the weather is warmer in July than in June when the days are longer and the sun higher, so the oscillations of the tide go on increasing after full of moon, and so the highest tides are not under the full moon but some days after! But at Albany Island the highest spring is frequently known to occur not after full and change, but actually a day or two before, and this explanation is worse than none. The oscillations begin to diminish before the moon is full! And there is need to invent some new hypothesis. Let me show you the secret. Albany Island is in 12° S. lat. There was full moon on the 6th of this month (May). Declination on that day was nearly 22°. Now on the 4th—two days before full moon—her declination was 12°, and Albany was on that day right in the apex of the tide. The full-moon tide was doubtless higher, *under the moon*, than the tide of the 4th, but its highest point was 12° away from Albany. The tide of the 4th was the highest for that place, for on the 4th the moon was in its zenith, and oscillations of the tide had nothing to do with this acceleration of highest water. Do I need a complicated analysis to tell me when highest water may be expected at Albany? I do not; and there is not an ordinary seaman, who can read, who cannot see and understand the reason of this acceleration for himself, if once he has grasped the simple law that I am expounding. Again, I am asked, "Why at Whampoa Docks are the tides of June 4 feet higher than those of March, whereas we are taught to look for the highest tides at the equinoxes?" I know we are taught so, but quite wrongly; The equinoctial tides are greatest at the equator, but for places situated above lat. 23°, the solstitial tides are the greatest. At equinox the luminaries at full or change are over the equator, but at solstice the full or new moon may be some 29° from the equator, and the apex of the tide will be under the moon. It is not that the tides at Whampoa are higher in June than in March by an accident—it is that they *must be so*, and again in December. You see how the tide being taken as normally under the moon there is no longer a puzzle of the tides: even the "simple sailor" will know what (relatively) to expect in the tide of any place, and when to expect it. The theory of Laplace and of Professor Darwin—that the tide is 90° behind the moon—explains nothing: it covers the sea with anomalies! I believe the arguments by which that theory is supported to be unsound: they are made up of false analogies and incorrect reasoning, which it would be worth while to show up if only there were time. The professors differ from me naturally, and I did not suppose that I could come here and, in one hour, overcome the prejudices of tradition, or persuade gentlemen whose lives have been spent in developing a certain line of thought to abandon their interpretation of Nature and the results of their life's work at my bidding. Scientific men are often ridden by their theories, and the formulæ of the mathematician sometimes hinder and cramp, instead of helping, thought. These great men are sometimes fettered—bound hand and foot—by their own formulæ. The Rabbis of the Temple of Science reject, as I expected they would, my interpretation of the Law. They will not show themselves more noble than those of mediæval Rome, and search the writings of Nature to see whether the things which I assert are so. They entrench themselves behind the ramparts of tradition and authority. Lo, I turn to the Gentiles! To the practical men who, fettered by no theories, want only *to know*, and I say to them, "Here is a system, not abstruse but simple, a system by which

you may readily tell when you will find water upon a harbour bar, summer or winter, night or day, spring tide or neap, northern hemisphere or southern.[1]

The CHAIRMAN (Sir W. J. Wharton):—I think I have very little more to do but to express the thanks of the meeting to Mr. Moxly. As he himself said, he could scarcely expect to come here and in the space of a couple of hours upset the received theory of the world. I must say I do not think he has gone very far towards doing it. It is an understood thing among Englishmen that when you preside at a meeting you do not render yourself liable to be charged with believing what is brought forward. I will ask you to join with me in a hearty vote of thanks to Mr. Moxly for having given us an opportunity of hearing his views, and of eliciting the very interesting discussion on the subject from Professor Darwin and others.

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[1] Want of time has crushed out, among many other things, the answer to a question put as to the reason why at Hong-Kong the tide should ebb for seven hours and flow for but five hours. A glance at the diagram will show that just as near the 60th parallel the tide will ebb for twelve hours and rise for twelve hours, so at Hong-Kong there should be ebb during one part of the diurnal rotation lasting longer than the rise in the succeeding part of the rotation, and then a fall of water lasting not so long as the succeeding rise. Thus, an observer might declare that the tide ebbed at Hong-Kong for seven hours and flowed for five; while another, who had observed the tide during a different period of the twenty-four hours of rotation, would assert that the tide ebbed for but five hours and rose for seven hours.—J. H. S. M.

THE STATE DEFENCES OF RUSSIA.

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THE matter here presented to the readers of the JOURNAL of the Royal United Service Institution is in no way original. It is simply taken *en bloc* from official Russian sources, which are at the disposition of each and every individual who walks into Thiele's shop in St. Petersburg. It has the advantage of presenting Russian official views, and absolutely correct figures to the British reader. But such complete information as to the Russian Army as is published by the Intelligence Branch at the Horse Guards is not to be expected here.

The foundation of a permanent Army and Navy in Russia was laid by the Emperor Peter the Great. Prior to that time most of the military forces consisted of temporary levies of military *Opoltchenie*, some of which were composed of nobles and the sons of boyars, who were distributed according to localities, and compelled to appear for service, mounted, fully accoutred, and provisioned at their own expense. Another portion of the Militia was composed of so-called "given people," *Sdatochny*, taken from among the peasantry, and sent home at the end of a war. Permanent service in time of peace was performed by the *Strelitsy*, town cossacks and bombardiers, principally in towns and fortresses. From the time of the Tsar Mikhail Feodorovitch (1616-45) it became the custom to hire foreigners; and these at first, and afterwards the nobility and "sons of boyars," were employed to form special regiments of cavalry and dragoons. During the reign of the Tsar Alexey Mikhailovitch regiments of infantry, composed of volunteers, were organised, but there was still no Regular permanent service. Those who served were engaged during most of the year in agriculture or industry, and were called together for only very short periods of drill. Peter the Great in forming a Regular Army, introduced general obligatory service from the very beginning, and entirely on his own idea, while the ranks of all the other European Armies were being filled by conscription, and the system of general obligatory service was adopted only a hundred years later. By *ukas* of Peter the Great, in 1699, the first operation of recruiting was carried out; and with the 32,000 recruits then collected were formed 27 infantry and 2 dragoon regiments, divided into three divisions. The recruiting was not personal, but communal, that is to say, each rural or urban commune had to furnish a certain number of recruits, and the selection of them was left to the communes themselves. Only the nobles, without exception, were compelled to serve for life until prevented

by complete exhaustion or old age. Thus, the system adopted by Russia at the beginning of the eighteenth century, was very different from the methods employed by the military authorities of the West European countries, in which volunteer recruits were enlisted, and sometimes pressed into the Service, or enticed into it by various forms of deception.

The obligation of military service in Russia extended to all classes of society. But in the course of time exemptions began to be made, as service for life was a grievously heavy burden; and these exemptions were gradually granted to all the higher classes of society, namely, the nobility, honorary citizens, merchants, and clergy. Exceptions were even made among the artisans and peasantry. The inhabitants of whole localities were sometimes relieved of the obligation of serving, which thus fell upon only four-fifths of the total population. The wars at the end of the eighteenth and beginning of the nineteenth century, however, compelled all the principal European States, except England, to replace voluntary recruiting by compulsory for military service. Armies began to be formed, not of volunteers, but of citizens called upon by the law to fulfil a sacred duty to their country. The obligation of military service was made personal, not admitting of exemption by payment or substitution, and it became compulsory for the whole male population of a certain age capable of bearing arms; but, at the same time, the service was limited for everyone in time of peace to the smallest term necessary for military instruction, and the formation of trustworthy cadres, wherewith to complete the Army in time of war. In Russia general compulsory service replaced the recruiting system in 1874, and the chief principles on which it was established are as follows:—All the male population capable of service, from the ages of 21 to 43, enter into the composition of the armed forces of the State. Some, however, belong to the Regular permanent troops, while others are counted as Militia, *Opoltchenie*, and are called out only in time of war, and then principally for service in the rear of the Regular Army. The general term of service in the Regular Army is 18 years, 4 of which are passed with the colours, and 14 in the Reserves, which correspond with the Prussian Landwehr. It must be noted, however, that the term of active service is considerably diminished in proportion to the degree of education, the shortest being only one year. Although military service is considered obligatory on everybody, nevertheless, in Russia, as in other States, a great many exemptions are made; as the full number of conscripts afforded by the whole population is not necessary to complete the cadres in time of peace. For instance, the cadres of the Russian Army on a peace footing represent about 900,000 men, called out for four years; consequently one-quarter of that number, or 225,000 conscripts, are required annually; but in view of completely filling up the ranks of the Army in case of war the yearly contingent is fixed at 265,000 men. At the same time the population furnishes yearly 880,000 men of 21 years of age, which is three times the required number. Therefore, the remaining two-thirds have to be relieved in some way or other from the duties of active service. The principal ground for exemption is physical incapacity, and for this

reason about 290,000 conscripts are made free of military service every year. In the next place, the privilege is granted for domestic reasons; as, for instance, in the case of an only son of a family, or an eldest son assisting his father when his brothers are unfit for work, etc. By right of their vocation the clergy of the Christian religion are entirely exempt. Medical men, dispensing chemists, teachers, etc., are at once included in the Reserves for 18 years. Finally a great many other persons are permitted to postpone their military service for physical and domestic reasons, and for the purpose of completing their education. The remainder of superfluous conscripts are exempted by drawing lots. Out of the yearly contingent of 265,000 men, about 6,000 are placed in the Navy, the remaining 259,000 being included in the Regular land forces. A special regulation regarding military service is applied to certain heterogeneous races at the Caucasus, who may pay a tax of money instead of furnishing conscripts. A special arrangement is also established for the Grand Duchy of Finland, according to which the term of service is only three years of active duty and two years in the Reserve, while these troops are compelled to serve exclusively in the local army.

As to the peculiarities of military service among the Cossacks, we shall have occasion to refer to them in subsequent remarks. The burden of military service is lighter for the population in Russia than in other States, both in the proportion of the annual number of recruits and in respect to the vast immunities that in Russia are granted on family grounds. Thus of the male population of 21 years of age—

	Enter the Service yearly, about	Are yearly exempt from serving	
		Through incapacity, about	On family grounds, about
	per cent.	per cent.	per cent.
France	76	23	0
Germany	45	42	2
Austria	34	57	4
Russia	31	12	51

The Land Forces.

All the land forces, according to the nature of service, are divided into Regular troops and Cossacks; and this Permanent Army is supplemented in case of war by the soldiers of the Militia Reserves, who are called out and organised into the formation units of the *Opoltchenie*. Every unit of formation (regiment, battalion, battery, etc.) has two establishments, one for peace and one for war. In time of peace only the cadres of the Army are maintained, and from those the full strength of its organisation is developed in war-time. As no State is in a position to maintain its Army permanently on a war footing, all Armies in time of peace do not represent more than one-fourth, or even one-fifth, of the entire armed strength of the country. At the same time,

the greater the importance of certain parts of the Army in time of war, the nearer their cadres approach to the war establishment in time of peace. For this reason all units of formation are kept up in the field army or active troops, from the company and squadron to the army corps, and full staff of commanding officers and administration. It, therefore, only becomes necessary in time of war to add about one-half the rank and file and a small number of junior officers. In the Reserve and fortress troops a much smaller proportion of the war establishment is maintained, and the Reserve troops are only organised in time of war. The same differences in the cadres exist in other separate branches of the Army. The peace establishment of the Army is placed on a war footing by means of mobilisation. All the officers and privates of the Reserve are then called into the Service. The requisite complement of horses is furnished by the population under compulsory regulations, and paid for out of the Exchequer. Finally, the additional material required for the full expansion of the Army is supplied from the reserve stores, which are kept intact, and consist of material property representing the extra requirements of the war service as compared with the peace establishment. The greater the strength of the cadres in time of peace, the quicker and more easily can the units of formation be mobilised, in other words, the fewer men and horses have to be added. In Russia the cadres of the peace establishment amount, in round figures, to 860,000 to 900,000 men, which is more than in any other Continental State of Europe. In Germany, for instance, there are 599,000, in France, 572,000, in Austria, 335,000, and in Italy, 222,000. But when the cadres in Russia are compared with the great distance and extension of her frontiers, one is inclined to call them comparatively restricted. The field forces of various arms are united in the highest strategical unit—the army corps. As a rule each corps consists of two infantry divisions and one cavalry division, with the corresponding artillery. Rifle and sapper brigades are not included in the army corps. There are 22 army corps in all, 19 of which are composed of troops of the line; the remaining 3 being the corps of the Caucasus, the Grenadiers, and the Guards. The Finnish troops, consisting of 9 rifle battalions and 1 Dragoon regiment, receive their full complement of men on a special basis from among the local inhabitants, and are stationed in Finland. They are under the order of a separate commander of Finnish troops. The Guard Corps is specially remarkable for the complexity of its composition. The Russian Guard was first formed in the time of Peter the Great from the Preobrajensky and Semenoffsky regiments, and gradually grew to the present number of 12 infantry and 12 cavalry regiments, 4 rifle battalions, a company (*sotnia*) of Ural Cossacks, 21 field and 6 horse artillery batteries, the detachment of Guard Marines, and a squadron of gendarmes of the Guard. All these troops enter into the composition of the Guard Corps, in addition to which the following are also included:—His Imperial Majesty's body guard of two squadrons of Cossacks from the Kuban, and two squadrons from the Terek, under the orders of the Commander of the Imperial Military Household; a company of Grena-

diers of the palace under control of the Minister of the Imperial Court; a Life Guard sapper battalion, and reserve detachments. Such is the composition of the Regular forces, to which, as we see, are attached certain regiments and batteries of Cossacks, who, by virtue of the character of their service, belong to the irregular troops.

As regards the latter, their origin must be referred to a very remote time. It is well known that a numerous military population gradually appeared on the south and south-eastern confines of Russia under the name of Cossacks. The word "Cossack" is Turkish, and means a "free man," a "free lance." The first Cossacks were settlers on the River Dnieper. When Russia after the Tartar invasion under Battui in the thirteenth century became divided into Muscovy and Russian Lithuania, a great many inhabitants of the present Little Russian provinces, having lost their country, retired to the islands of the Dnieper, guarded by rocks, impassable reeds and swamps. Here they welcomed everyone who was oppressed, and in general all refugees from all countries and peoples. Out of this free population in the region of the Dnieper gradually arose a martial, Christian society or knighthood, called by the name of "Cherkess" and subsequently "Cossacks." They soon became divided into two castes—married men and bachelors. The married Cossacks settled throughout Little Russia and the Ukraine, where they took to agriculture, and became a kind of Polish nobility. This helped the Polish Government in its efforts to bring the Cossacks under subjection. Accordingly at the end of the sixteenth century, under Stephen Bathory, a decree was issued which created a body of free Cossacks of 6,000 families from among the population of the Ukraine, with the right of electing their own colonels, but with dependence on the hetman of the Crown. Thus the Cossacks were transformed into a small force of Militia, and those who did not enter its ranks were reduced to serfdom. But this reform did not completely succeed. Besides the Cossacks recognised by the Government, there appeared other free and independent Cossacks, who retired to inaccessible islands beyond the rapids of the Dnieper, where they constructed a fortress called the *Syetch*.

In course of time the greater part of the Cossack troops lost their original importance, but the Government has always endeavoured to preserve their military organisation and martial spirit for the purpose of reinforcing the Regular Army with cavalry, and thus curtailing the regular contingent of this expensive branch of the Service. At the present time the Cossack population of the Empire occupy several extensive territories, and comprise eleven bodies of Cossack troops. These are, reckoning from West to East, the Don, Kooban, Terek, Astrakhan, Ural, Orenburg, Semiretchie, Siberian, Trans-Baikal, Amour, and Oosoorie Cossacks. The most numerous are those of the Don, Kooban, and Orenburg. The fundamental idea of the present regulations of military service, which is obligatory service for the entire male population, has been the chief rule of the Cossacks from the earliest times. They all possess definite and considerable allotments of land, and enjoy various privileges, in return for which one and all are bound to serve as soldiers. Each body of

Cossacks has its own service constituent and Militia Reserve. The service constituent is divided into thr kinds, namely, the preparatory, active, and reserve troops. Cossacks from 18 to 21 years of age are reckoned in the preparatory contingent, and from 21 to 33 in the active troops. Active service, however, lasts only four years, during which the Cossacks thus serving are reckoned in the first category. They must provide their own uniforms, equipment, and horses. At 33 years of age the Cossacks pass into the Reserve, and after 38 into the Militia Reserve or *Opoltchenie*. The Commander-in-Chief of all the Cossack troops with the title of Ataman, is the Heir-Apparent Cesarevitch. Each separate Cossack body is under the immediate command of a deputy ataman, who also governs the local civil administration. Whenever there is a governor-general, the above title belongs to him, and special deputy atamans act under his orders.

In time of war the various Cossack populations furnish his Majesty's body-guard, 146 cavalry regiments, 39 separate squadrons, 20½ infantry or so-called plastoon battalions, and 38 horse artillery batteries, representing the regulation total of 176,000 rank and file. In peace only one-third of these regiments, battalions, and batteries are in service, the rest being allowed the privilege of exemption. The irregular cavalry also include, besides Cossacks, other variously named bodies of troops formed among the native races of the Caucasus and Trans-Caspian region. Some of these perform principally local service, and have no permanent or uniform organisation. Of this character are the Daghestan cavalry regiment, the Militia regiments of the Kooban, Terek, Daghestan, Kars, and Batùm, and the division of irregular Turkoman cavalry.

Organisation of Military Administration.

Supreme command over all the military forces of the Empire is concentrated in the person of His Majesty the Emperor. The wishes of the supreme power in relation to the land forces are carried out by the Minister of War, to whom is subordinate the administration of military circuits in their respective localities, having the management both of the troops and all establishments necessary for the Army and defence of the State. In regard to the military circuits, of which there are 13, viz., St. Petersburg, Finland, Vilna, Warsaw, Kieff, Odessa, Moscow, Kazan, Caucasus, Toorkestan, Omsk, Irkùtsk, and Pri-Morskaya; these, as already stated, are territorial units, in which command over all the troops is concentrated in the hands of one person commanding the troops of the circuit. Under him is a circuit staff, circuit departments of the commissariat, artillery, engineers, and medicine, besides a circuit court-martial. There is also a Military Council of the circuit, which is the highest institution for matters of military economy within the circuit, and is composed of all the chiefs of separate departments and one representative of the Minister of War, under the presidency of the commander of the troops or his assistant (Adlatus). The relation of the circuit administration to the circuit is the same as that of the Ministry of War to the whole

Empire; directing, as the latter does, the action of all local organs, and superintending all branches of military administration.

The Minister of War reports to the Emperor on all matters of military administration, signs Imperial orders, and announces the commands of the Tsar to the military authorities. The Ministry itself is composed of several parts. It contains two superior institutions called the Military Council and the Chief Military Court of Justice. The Military Council discusses all legislative matters, and the more important affairs relating to economical administration. In matters of legislation concerning only military jurisdiction, the resolutions of the Council are submitted directly to the Emperor. Other resolutions are placed before the Council of State Economical questions are decided for the most part by the Military Council, on its own authority. The Council is directly subordinate to the supreme power, and assembles under the presidency of the Minister of War. Attached to the Council are two superior committees, one of military codification, for the investigation of legislative questions; and the other of military sanitation. Another superior institution of the Ministry is the Chief Military Court of Justice, which acts as a Court of Appeal, and also examines the projects of laws relating to courts-martial in general. The remaining central institutions of the Ministry of War are of a bureaucratic character. First comes the Grand Staff, in which are concentrated matters relating to the personal composition and completion of the ranks of the Army, its organisation, instruction, distribution, and economy. Then comes the Chancery or Office, for matters which are decided directly by the Minister, and for the work of the Military Council. For separate parts of military administration there are several superior departments, similar to those of the Military Circuits, namely:—1, Commissariat; 2, Artillery; 3, Engineer; 4, Military Medical Departments; 5, Military Educational Department, controlling all military educational establishments, besides the academies, officers' schools, special and *yunker* schools, which are subordinate to the Grand Staff; 6, Superior Department of Administration of Cossack troops; and 7, Superior Department of Military Justice, under the authority of the Military *procuror*, which is something like a Ministry of Military Justice, and which superintends all *procurors* and courts.

The Imperial Military Household, or staff, exists for the purpose of taking the Emperor's personal orders and carrying out special instructions. It has a commander, and is composed of all adjutants-general and generals of His Majesty's suite, aides-de-camp, and several other officers constituting the war staff of the Emperor. The Imperial Staff also includes an office and His Imperial Majesty's convoy, or body-guard. The duties of the commander include all arrangements for the journeys of the Emperor, for distribution of members of the Imperial Staff, and for their supply of provisions. When the Minister of War is not in attendance on the Emperor while travelling, the commander of the Imperial Staff receives the orders of His Majesty on military matters, and reports them to the Minister of War. The military administration has to do with such a great number of people and their multifarious

requirements, that a complete system has to be organised for the satisfaction of their peculiar wants and necessities. It is enough to mention that about a fourth of the Budget (288,000,000 roubles) is absorbed by military expenditure. First come the victualling arrangements; the constant fluctuations in the price of grain render these very difficult. Provisions prepared by the intendant, or commissariat authorities, are kept in special warehouses. A very large quantity has to be stored in reserve on the frontier districts in case of mobilisation, and there is a great difficulty in keeping it always fresh. As flour, in particular, soon spoils by keeping, a portion of the bread-stuff is stored in grain, and converted into flour and bread as required in military steam flour-mills and baking-ovens on the spot. The preparation of clothing, boots, etc., is not less difficult when it is considered that the expenditure for this purpose exceeds 20,000,000 roubles annually; but, besides this, there are paramount requirements of the troops in weapons, guns, ammunition, etc.

After the war with Turkey in 1877-78, all the materials and the armament of the troops was found to be either useless or very imperfect. The late Emperor Alexander III., who was convinced of this, devoted the whole of his reign to the re-organisation and re-armament of the fortresses, the re-armament of the troops, the improvement of their instruction in formation, drill, etc. It will suffice to note that the ordinary assignment for improvements in artillery amounts in Russia to 11,000,000 roubles. For the re-armament of the troops with the latest pattern of rifle, from 33 to 34 million roubles have been allotted during recent years. It is impossible to order rifles, shell, etc., from private factories, as such do not exist, or are very few in number. Therefore the military authorities must maintain factories and arsenals of their own. There are three such rifle factories, the most celebrated of which is at Toola; also the St. Petersburg artillery factory; three powder and pyroxaline factories, cartridge and rocket factories; and three arsenals at St. Petersburg, Briansk, and Kieff respectively. The engineer authorities have equally complicated work to perform, such as the construction of fortresses, barracks, and so-called strategical roads. The Ministry of War has also constructed entire lines of railway like the Trans-Caspian, which is still under the direction of the military authorities. Even the civil administration of certain regions is under the control of the Ministry of War, especially in territories close to the Central Asian frontiers, such as the Trans-Caspian, Toorkestan, and Trans-Baikal provinces, and also where the population consists principally of Cossacks, as on the Don, the Terek, and the Kooban. Consequently very extensive and various knowledge is required of those serving in the military administration, and this necessitates the existence of an entire system of military education.

The moral as well as the fighting qualities of the Army depend upon good officers and non-commissioned officers, but this is not enough. The recruits can hardly become good soldiers without at least some rudimentary instruction; and in this respect the military service becomes a powerful aid to national education, especially in States where this is

very little developed. In Russia about 75 per cent. of the conscripts are totally unable to read or write. In other words, out of 265,000 men drafted into the Army every year, 198,000 are in this state of utter ignorance. On entering the Army they are taught to read and write in their respective companies and squadrons. They are instructed in elementary information necessary to every private, which consists in a knowledge of certain prayers, of the meaning of a soldier's calling, the oath, the flag, the titles of the members of the Imperial Family, etc.; so that compulsory military service converts 200,000 of the population every year into men able to read and write. Some of the more capable soldiers are sent into the company schools, where they learn arithmetic, as well as reading and writing. For the purpose of preparing privates to become non-commissioned officers, each regiment has an "educational command," or detachment. Finally, in addition to the position of non-commissioned officer, there are other auxiliary duties devolving upon members of the rank and file, which also require a certain amount of preparation and instruction such as those of the regimental scribe, or *feldsher*, assistant surgeon, etc., for which there are a large number of special schools. In the Cossack provinces the Ministry for War has introduced military trade schools.

The establishments in which young men are prepared to be officers are divided into three categories. In some of them elementary education is given to the degree necessary only for service in separate branches of the Army. These are the *yunker* schools of the infantry, cavalry, and Cossacks. In other establishments, or so-called military schools, the instruction in military science is on a more extensive scale. Of these there are two for infantry, two for artillery, and one each for the cavalry and engineer troops and military topographers. Among this number of cadet corps there are two, namely, the Imperial Corps of Pages and the Finnish Corps, which possess the addition of special classes taking the place of the military schools. The Corps of Pages educates children of persons who have served the State, and they gradually leave that establishment to take service in the Guards. The third category of military educational establishments comprises the military academies for furnishing officers with the highest education necessary in special branches of the Service. The first of these is the Nicholas Academy of the Grand Staff, with its geodesical section; after which rank the Michael Artillery and the Nicholas Engineer Academies, and the Academy of Military Jurisprudence. Superior officers who have served several years are admitted into the academies on examination. The course of study lasts two or three years, with a supplementary course. For the preparation of officers for service on the Eastern confines of the Empire, there is an officers' course of study in Oriental languages of three years' duration in connection with the Ministry for Foreign Affairs. Besides the educational institutions above enumerated, three schools have lately been established for giving a perfect knowledge of the various arms of the Service and for preparing them to occupy independent posts. These are the Rifle and Cavalry Schools, and the Artillery School for practice in firing with fortress section. The Cavalry School also trains expert non-commissioned

officers as riders and smiths. The following are the regulation numbers in the above-mentioned institutions:—

In 23 corps of cadets	8,135	men
In 14 yunker schools	3,590	„
In 7 military schools	2,045	„
In 4 officers' schools	270	„
In 4 academies, together with the class for Oriental languages	509	„
	14,549	men

In 1893, 2,372 young men left these institutions with the rank of officers, and as the diminution in the number of officers during that year was not more than 1,651, the military educational establishments are fully capable of satisfying the demand. The total expenditure of the Ministry of War on military education amounts to 9,000,000 roubles.

The enormous numbers of the Army give rise to two more military questions, namely, the preservation of the health of the troops, and the cure of invalids. The average number of sick in the Army during the last few years has been about 25,000 men daily. For their care and treatment there are about 25 permanent hospitals and 165 lazarettos, with altogether 28,000 beds. In places were no lazarettos exist, they are organised among the troops themselves. In the event of war, this accommodation for the sick is considerably increased by the addition of field and fortress hospitals, the ambulances of the Red Cross Society. The one deficiency which makes itself felt is the inadequate number of doctors, chemists, veterinary, and assistant surgeons, although the military authorities have their own Academy of Military Medicine for 750 students, and schools for assistant surgeons or *feldshers*. On the other hand, the general sanitary condition of the troops is much better than in former years. In the forties of the present century the rate of mortality in the Army was every year as much as 37 per 1,000. It has ever since continued to decline, and in 1892, in spite of cholera, there were not more than 9 deaths to the 1,000. But it still stands higher than in any other European State, as, for instance, in Germany, where in 1880 and the following years the death-rate was not much more than 3 per 1,000. There are many benevolent institutions of the military authorities; and the Alexander Committee for the wounded founded in 1814, under the presidency of the Grand Duke Michael Nicholaivitch, grants pensions for invalids, looks after the wounded, procures them occupations, medical assistance, etc. The asylums of the Alexander Committee are very numerous. At St. Petersburg is the Chesma Asylum for 746, and at Moscow the Ismaïl Asylum for 458. As regards size, these rank next to the celebrated Hôtel des Invalides at Paris for 5,000 inmates, and are larger than the homes for invalids in Berlin and Vienna.[1] But the concern of the Government for its invalid soldiers is not confined to placing them in hospitals and asylums. Many private soldiers receive help from the Exchequer at the rate of three roubles per month, and some are placed under the care of trustworthy persons, who are paid a certain remuneration.

[1] The details and figures as to medical matters are no longer reliable.

SMOKELESS POWDERS, OF NITRO-GLYCERINE TYPE.

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THE evolution in the manufacture of powders for war purposes, which originated in 1885, and was commenced by France, has been continued abroad, and consists in the employment of nitrated organic explosives of great power; these explosives, whether employed in fire-arms or mines, produce the same effect as charges of black powder three or four times larger, and have the advantage besides that they do not disengage any smoke in deflagrating—a very important qualification from a tactical point of view.

It was at the end of 1884 when, thanks to the researches of M. Vieille, a process of manufacture for a smokeless powder, based on the employment of nitro-cellulose in a colloidal state, was initiated at the Central Laboratory for powder and saltpetres. This process permitted the mode of combustion of the nitrated explosives to be regulated, and as a result to allow of their employment in and adjustment for guns of any given calibre. Rendering possible in portable fire-arms with equal pressures an increase of initial velocity of 100 metres above that given with black powder, this discovery could not rest without rivalry in other countries. It was the signal for a series of experiments on the part of foreign engineers, and in 1888 the Swedish chemist Alfred Nobel obtained a patent for a smokeless powder containing nitro-cellulose and nitro-glycerine.

The known smokeless powders may be classed in three categories. First: Powders containing nitro-cellulose only; either soluble in a mixture of alcohol and ether, or insoluble, or a mixture of the two kinds. To this category belong the French powder B, the Russian powders (including the pyro-collodion powder of Mendéléyef, used in the Russian Navy), the Belgian powder of Wetteren, the German flake powder, and the Austrian Schwab powder. Secondly: Powders composed of nitro-glycerine and nitro-cellulose. To this category belong the Nobel powders (ballistite, Italian or German; filite, Italian), which are composed of nearly equal parts of soluble nitro-cellulose and nitro-glycerine, either mixed or not with one or two parts of inert substances (aniline, diphenylamine, camphor, etc.); to the same category also belongs the English cordite, composed of nitro-glycerine, of insoluble nitro-cellulose and vaseline, and the Austrian gunpowder, model 1893, composed of nitro-glycerine and insoluble nitro-cellulose. Finally, the American Maxim powder and certain other analogous powders may be classed under this head, although they contain only a very slight proportion of nitro-glycerine (5 to 10 per cent.). Thirdly: Powders composed of nitro-cellulose, mixed with nitrates

obtained from certain aromatic carburets. This category comprises only a few samples; we may instance indurite of the American professor Munroë, prepared with insoluble nitro-cellulose and nitro-benzine, and the Dupont powder of the American firm Dupont and Co., composed of the same elements. Besides these powders, of which we propose to treat, a number of others have been proposed, varying greatly in their composition; but, generally speaking, the results obtained from them have not been entirely satisfactory. Without further delay in dealing with powders of the first and third categories, we proceed with the second, or nitro-glycerine powders, which form the especial object of the present article.

Composition and Properties of the Principal Nitro-Glycerine Powders Nobel Powders, or Ballistite.—The Nobel powders, which have been experimented with by different countries since 1889, have given good results from a ballistic point of view. When used in guns they have even proved superior in this respect to pure nitro-cellulose powder. In spite of the favour with which they have been regarded for some time abroad, Italy is the only country where they have been adopted exclusively as the regulation powders. We are already aware that the Nobel powders are composed of a mixture in nearly equal parts of soluble nitro-cellulose and nitro-glycerine. This composition has been adopted by reason of the influence exercised on the consistency of the mass by the excess of one or the other of those substances. If there are more than two-thirds of nitro-glycerine in the powder it becomes soft and too plastic; if, on the contrary, there are more than two-thirds nitro-cellulose the substance becomes hard and difficult to granulate. The first samples of powder prepared by Nobel contained 70 per cent. of nitro-glycerine and 30 per cent. nitro-cellulose; for these reasons we propose to point out what has led up to the actual composition. The addition of a small quantity of camphor, 1 to 2 per cent., moderates the rapidity of combustion in the chamber, and reduces the sensibility to shock. The evaporation of the camphor, however, which always takes place in time, causes these advantages, little by little, to disappear, and the powder therefore does not remain constantly comparable in its results. With the view of lessening this inconvenience, the quantity of camphor was at first reduced to $\frac{1}{4}$ or $\frac{1}{2}$ per cent., and then replaced either by tannin or aniline, particularly in the Italian ballistite. At the commencement the nitro-cellulose employed by Nobel in his powders was ordinary collodion, and contained from 11 to 12 per cent. of nitrogen (azote). Since 1893 the Nobel manufactures have succeeded in making soluble nitro-cellulose, containing from 12 to 12·2 per cent. of azote, which, as we shall see further on, has permitted of the explosive effects of the powder being increased. Powders of the Nobel type for portable arms are in the form of cubical grains of dimensions varying according to the calibre and of a dark cherry-red colour. For the Italian Vetterli rifle the grains are ·9 millimetre thick, for the revolvers only ·2 millimetre. The powders for big guns are in the form of prisms of square section, whether in sheets or threads: in the latter case it is called filite. This is also employed in Italian artillery.

Cordites.—In England the nitro-glycerine powders have been, in a general manner, the name, or cordite when prepared in the form of filaments resembling cord. This denomination, however, is more specially applied to the powder invented by the chemists Abel and Dewar. The composition of the Abel and Dewar cordite varies with the calibre of the arm in which it is to be used. It always contains insoluble nitro-cellulose, nitro-glycerine, and vaseline; this last substance serving to lower the temperature of the explosion. The following table shows the composition of the two samples generally used:—

Powder for portable arms (filaments, ·85 millimetre to ·88 millimetre in diameter, and 36 millimetres in length):—

Nitro-glycerine	57·4 per cent.
Nitro-cellulose	37·0 ,,
Vaseline	5·4 ,,
Water	·2 ,,

Powder for guns of 12 centimetres, Armstrong (filaments, 4·5 millimetres in diameter, and 350 millimetres in length):—

Nitro-glycerine	56·5 per cent.
Nitro-cellulose	37·6 ,,
Vaseline	5·6 ,,
Water	·3 ,,

Austrian Powder, Model 1893.—This powder for field-guns of 9 centimetres has the peculiarity that it is composed only of nitro-glycerine and insoluble nitro-cellulose without the addition of any vaseline or other mineral grease, as is the usual practice with powders containing insoluble nitro-cellulose. The composition of this powder is as follows:—

Nitro-glycerine 49·4, per cent.; nitro-cellulose, 50·3 per cent.; water, ·29 per cent. It has, as we see, much analogy as regards its composition with the Nobel powders; it is distinguished by the employment of insoluble nitro-cellulose. This powder is prepared in the form of grains cylindrical in shape 1·4 millimetres to 1·7 millimetres in diameter and from 3 to 5 millimetres in length. These grains are polished by graphite, which diminishes their sensibility to shock.

Maxim Powders.—The samples of Maxim powders proposed in 1888 by the Maxim-Nordenfeldt firm contain variable proportions, but always very weak; of nitro-glycerine; a small quantity of ricine oil is added, a carburet which tends to lower the temperature of combustion. We give below the composition of two samples of rifle powder proposed by Maxim:—

Sample No. 1.—Nitro-cellulose	94 per cent.
Nitro-glycerine	5 ,,
Ricine oil	1 ,,
Sample No. 2.—Nitro-cellulose	88 per cent.
Nitro-glycerine	10 ,,
Ricine oil	2 ,,

Nitr-Glycerine Powders Compared with those of Pure Nitro-Cellulose.—The advantages of the former over the latter are very real from a ballistic point of view, and permit of greater velocities being obtained with less pressures; this is shown in the following table, which gives the results of some experiments carried out in Russia:—

Powder employed.	Russian Rifle of 3 lines = 7·62 millimetres.			Russian light Gun of 87·0 millimetres.		
	Charge.	Initial velocity.	Pressure.	Charge.	Initial velocity.	Pressure.
	Grammes.	Metres.	Atmospheres	Grammes.	Metres.	Atmospheres.
Ballistite (in grains) ...	2·00	615	2250	629	525	1350
Cordite (Abel)	2·85	615	2550	—	—	—
Maxim Powder (containing only 5 per cent. of Nitro-glycerine)	1·95	615	2800	—	—	—
French Powder (from pure Nitro-cellulose)	2·45	615	2700	715	525	1400

The combustion of nitro-glycerine powders is by parallel layers and is effected in a more regular manner than that of the nitro-cellulose. This fact is due to the greater compactness of the mass and the absence of porosity in the first-named. These powders also work more easily than those of nitro-cellulose on account of their greater malleability, and can be given the most varied forms of cubic or prismatic grains, flakes, filaments, etc., and thus supply a very easy solution of the problem of how to adapt a given powder to arms of different calibres. They are also easier to make than those of nitro-cellulose, besides which the presence of nitro-glycerine as a dissolvent of the nitro-cellulose suppresses or diminishes the quantity of volatile dissolvent necessary in manufacture, and thus reduces the cost. On the other hand, from other points of view the nitro-glycerine powders have certain great disadvantages. The temperature of combustion is about 500°[1] higher than that of pure nitro-cellulose powders, 2,700° as against 2,200°, and this element plays a very important part in the conservation of the gun. Thus in guns of large calibres the deterioration produced by nitro-glycerine powders is sensible after the tenth round. This defect is lessened by a reduction of the quantity of nitro-glycerine as has been done in powders of the Maxim type, but such powders have little advantage from a ballistic point of view over the pure nitro-cellulose powders.

Nitro-glycerine powders appear to have a greater tendency to decomposition under the action of heat than those of nitro-cellulose. Finally, the nitro-glycerine powders of the ballistite and cordite types have the property of freezing under the influence of cold temperature of relatively small intensity. Beyond the fact that this congelation may be the cause of miss-fires it may also happen that it may cause a modification in the explosive properties of the powder.

Properties and Mode of Obtaining Nitro-Cellulose and Nitro-Glycerine.—Before considering the question of the manufacture of nitro-glycerine

[1] All temperatures are in centigrade.

smokeless powders it will be useful to enumerate the properties of the two fundamental substances which enter into these compositions. *Nitro-cellulose*:—This is one of the elements in the constitution of all smokeless powders, and results from the action of nitric acid on the cellulose which may be in various forms (cotton, paper, straw, etc.). According to the degree of concentration of the acid we obtain the following compounds:—

$C^{24} H^{29} (NO^2)^{11} O^{20}$	endecanitric	cellulose	with	13·51	per cent. azote.
$C^{24} H^{30} (NO^2)^{10} O^{20}$	decanitric	,,	,,	12·75	,, ,,
$C^{24} H^{31} (NO^2)^{9} O^{20}$	enneanitric	,,	,,	11·93	,, ,,
$C^{24} H^{32} (NO^2)^{8} O^{20}$	octonitric	,,	,,	11·11	,, ,,
$C^{24} H^{33} (NO^2)^{7} O^{20}$	heptanitric	,,	,,	10·11	,, ,,
$C^{24} H^{34} (NO^2)^{6} O^{20}$	hexanitric	,,	,,	9·15	,, ,,
$C^{24} H^{35} (NO^2)^{5} O^{20}$	pentanitric	,,	,,	8·03	,, ,,
$C^{24} H^{36} (NO^2)^{4} O^{20}$	tetranitric	,,	,,	6·76	,, ,,

Endecanitric cellulose forms the cotton powder. It is insoluble, except in acetic ether and acetone.

Decanitric cellulose is a cotton powder almost insoluble, except by acetic ether and acetone.

Enneanitric and octonitric celluloses form the collodions; they are soluble as above and in a mixture of alcohol and ether.

The less nitrated celluloses form a friable cotton. They preserve the appearance of cotton, but become gelatinous without truly dissolving under the action of solvents. Both insoluble nitro-cellulose (cotton powders) and soluble nitro-cellulose (collodions) are employed in the manufacture of smokeless powders. Cellulose with inferior nitrification to the collodions do not detonate and cannot be used as explosives. In most of the pure nitro-cellulose powders both of the above kinds are used and yield a substance capable of being gelatinised to a certain extent in the ordinary solvents: acetic ether, alcohol and ether, etc. The explosive effect of these powders depends on the quantity of insoluble nitro-cellulose contained in the mass, for the pressures developed in a closed vessel by different kinds show that the force generated diminishes rapidly with the measure of nitrification. The proportion of azote forms a true measure of the explosive qualities of the powder. In the nitro-glycerine powders of the Nobel type, which owe their explosive force principally to this substance, only soluble nitro-cellulose is employed; and from what has been said the more this substance is azotised, while still remaining soluble, the greater is the explosive effect in equal quantities of nitro-glycerine. In Abel's cordite only insoluble nitro-cellulose is used, as already mentioned. The powder industry has thus been led to the production, both in soluble as in unsoluble nitro-cellulose (cotton powder), of that which contains the largest proportion of nitric acid.

The fabrication of pure cotton powder is carried out by the process indicated about 1865 by the English chemist Abel. It is due to the labours of this expert that cotton powder, which up to this period was considered a substance very dangerous to handle, has taken such an important place in military practice. The process of Professor Abel

consists in nitrifying the cotton, previously cleaned and dried, by concentrated nitric acid and sulphuric acid, and then to eliminate all trace of the acid by washing and drying, reduce it to a paste by a pulping machine, and then to compress the cotton powder thus obtained in special moulds to give it the required forms. The great advantage of the Abel process resides in the complete elimination of the traces of acid, and in this way to insure a great stability in the cotton powder and avoid all danger in its manipulation.

Manufacture of Soluble Nitro-Cellulose.—The collodions are obtained by a process of manufacture analogous to that of cotton powder, but diluted instead of concentrated nitric acid is employed. Ordinary collodions are heterogeneous in composition, and contain from 11 to 12 per cent. of nitric acid (azote). We have already said that the trade has endeavoured in recent years to obtain collodions as homogeneous and nitrated as possible. The results as yet obtained are not completely satisfactory. Very often the retention of azote in the products is not constant, and different samples do not behave always in the same manner when subjected to a mixture of alcohol and ether. Whilst one sample will dissolve at once like sugar in water, the other may take the form of jelly before dissolving. The Nobel works, however, employ in the manufacture of ballistites, collodions containing from 12 to 12·2 per cent. of azote, and completely soluble. The Russian chemist Mendéléyef proposed a process in 1892 for the preparation of nitro-cellulose containing about 12·5 per cent. of azote completely insoluble in alcohol, but soluble in a mixture of alcohol and ether without previously forming a gelatine. In a small quantity of the same mixture this substance, which Mendéléyef calls pyro-collodion, takes the form of jelly without dissolving. The composition of pyro-collodion is expressed by the formula $C^{30}\ H^{38}\ (NO^2)^{12}\ O^{25}$, which indicates a proportion of 12·44 per cent. of azote. It is therefore an intermediate substance between the collodions and cotton powder. The employment of pyro-collodions for the manufacture of powders, in which soluble nitro-cellulose must be used, should apparently give very good results. The military powder factory at Port Galère, St. Petersburg, uses pyro-collodion for smokeless powders for naval purposes. The chemist Eder has indicated a process for obtaining a nitro-cellulose containing nearly 12·75 per cent. of azote, but it is only a laboratory process.

The nitro-cellulose used in making smokeless powders is always in tufts or flocks, resembling tufts of wadding or of the cotton from which it is formed. Endeavours have been made for a long time to replace the cotton by other fibrous substances not so costly; thus in "Schultz"[1] powder wood bark treated with nitric acid was used as early as 1868. Different countries have carried out similar experiments with wood fibre, but as yet it has not been possible to obtain the necessary stability with these products. Improvements in the purification process of these ligneous fibres must nevertheless shortly cause a renewal of the researches in question. The nitrated cotton resembles ordinary cotton externally,

[1] Schultz powder is composed of nitro-lignite, nitrate of baryta, and nitrate of potash.

but is a little rougher to the touch; the colour varies from dark yellow to white according to the amount of washings in carbonate of ammonia solution. It is inodorous and insipid to taste when prepared with care. We have already seen that the solubility of the nitro-celluloses depends on the degree of nitrification; all however dissolve when they are subjected to a large excess of acetone. In nitro-glycerine the insoluble nitro-cellulose does not itself dissolve except in the presence of acetone. On the contrary, the collodions partly dissolve at normal temperatures, and completely at a temperature of 50° C. On this property Nobel has founded the preparation of his smokeless powders.

If imperfectly purified, cotton powder is a product very unstable and dangerous to handle; it is not the same with the cotton prepared by the Abel process, which may be kept for many years without spontaneous decomposition. Slow decomposition is produced, however, if the nitrated cotton is submitted to the action of solar light for many days, and results in the disengagement of nitrous vapours and the formation of traces of acetic, oxalic, and formic acids and of glucose. Wet cotton powder (gun-cotton) is still more stable than dry. The chemist Hess has shown that wet cotton powder kept for a long time suffers alterations, which are revealed by the production of gummy masses, which cannot be separated by washings in water. The nitro-cotton powder does not contain sufficient oxygen to completely transform the carbon into carbonic acid; the result of this is that the products of decomposition comprise a notable quantity of carbonic oxide. When, therefore, we are obliged to employ powders containing nitro-cellulose in closed places, such as in casemates, due provision should be made by means of ventilation to prevent any injury which would be caused by the presence of such a deleterious gas as carbonic oxide.

Nitro-Glycerine.—Nitro-glycerine [$C^3 H^5 O^3 (NO^2)^3$] is obtained by pouring glycerine [$C^3 H^3 (OH)^3$] into a mixture of nitric and concentrated sulphuric acid. The product is freed by washing from any trace of free acid. The use of nitro-glycerine as an explosive is due to the chemist Nobel, who, about 1868, originated the idea of mixing nitro-glycerine, considered up to that time as a very dangerous material, with an inert matter. He thus obtained dynamite, which offers much greater safety in management than nitro-glycerine. It was the same chemist who discovered later that nitro-cellulose and nitro-glycerine, which are such dangerous substances to handle separately, on the contrary, when mixed together form a product of very great security in management.

Nitro-glycerine is a very toxic, nearly colourless, oily liquid; prolonged contact of the liquid with the hands occasions headaches and syncope. It is insoluble in water, but dissolves in ether, benzine, and alcohol. In a state of purity it is very stable, and has been kept for twenty years without alteration. Very feeble traces of acid, however, suffice to make it detonate spontaneously, and heated to 180°C. it decomposes with explosion. It is much more sensitive to shock than nitro-cellulose. The quantity of oxygen enclosed by nitro-glycerine being

sufficient to transform all the carbon of the substance into carbonic acid, the explosion does not disengage carbonic oxide as is the case with nitro-cellulose.

Preparation of Nobel Powders.—At the commencement of the manufacture of Nobel powders, the process invented by Nobel himself was exclusively employed. Since 1890 the majority of the factories employ the Lundholm and Sayers process, which permits of a more simple method of mixing the nitro-glycerine and soluble nitro-cellulose. In the Nobel process a certain quantity of soluble nitro-cellulose at a temperature of 6° to 8° is treated with six to eight times its weight of nitro-glycerine. The operation is carried out in a special receptacle, from which the air is exhausted by an air pump. The bubbles of air which escape from the mass are replaced by the nitro-glycerine, which permeates the pores of the nitro-cellulose. The mixture thus obtained is then compressed in presses so as to squeeze out the excess of nitro-glycerine. The pressing is continued till the mass contains only one part of nitro-glycerine to one part of nitro-cellulose. The product is then broken up and heated to 80° in suitable pans. After a time, more or less extended according to the size of the fragments, the mass becomes plastic, becomes gelatinised, and the mixture of the substances being then intimate it is not possible to extract nitro-glycerine from it by compression. The gelatinous cake is then laminated by a laminating instrument, or by means of presses.

The Lundholm and Sayers process is that usually employed in the manufacture of Nobel powders. It is based on the fact that the mixture of the soluble nitro-cellulose with the nitro-glycerine is rendered much easier when the former substance is much attenuated with water. The nitro-cellulose and the nitro-glycerine are placed in a receptacle containing hot water, and the mixture is violently agitated by passing air or steam through the mass. When gelatinisation is produced the mass is first compressed so as to expel the greater part of the water, and then laminated between cylinders heated to 50° or 60°. The repeated laminations insure the expulsion of a certain quantity of moisture and the production of a compact and homogeneous cake; a part of the remaining moisture is eliminated by evaporation, the cylinders being maintained at a convenient temperature for the purpose. After lamination the cakes are granulated and then dried. During the operation of lamination, small explosions are sometimes heard; according to some writers they are due to the bursting of air bubbles in the mass. It seems more probable that they are particles of nitro-cellulose which cause the explosions, this substance being sensitive to shock and friction at a temperature of 60°. This supposition would also explain the presence in the mass of burnt portions of this substance. These explosions are quite local and not in any way dangerous. The Lundholm and Sayers process necessitates a desiccation of the powder, which was not required in the Nobel process. It can be effected either by prolonged exposure to the open air, or in stores maintained at a temperature not above 40°, so as to avoid evaporation of the nitro-gyclerine.

Preparation of Cordite.—The process invented by Abel and Dewar consists in mixing insoluble nitro-cellulose with nitro-glycerine by the aid of a solvent, such as acetone. The cotton powder employed at the English factory at Waltham Abbey for this manufacture contains a minimum of 12·5° of azote. The mode of operation is as follows:—A mixture of nitro-cellulose previously dried and of nitro-glycerine weighing altogether about 34 kilogrammes is worked up carefully with the hands and then placed in a special mixing vessel, the bottom of which is hollowed out in the form of two half cylinders side by side, in section like the Greek letter ω, with small propeller-shaped arms mounted in the axis of each half. These small propellers work in opposite directions, and the speed of revolution of one of them is half that of the other. Each portion of the mixture passes alternately from one cylinder to the other whilst being triturated by the arms, and the difference in the speed of rotation in the arms insures the successive kneading of all parts of the mass. The mixture is cooled during the operation by a current of water circulating in the space formed by the double sides of the box. In order to charge the mixer, the cover is raised, the nitro-glycerine and nitro-cellulose mixture is put in, and acetone poured into it in the proportion of one-fifth by weight; the cover is then hermetically closed to prevent the evaporation of the acetone. The first milling process lasts 3½ hours, vaseline is then added and the process is continued another 3½ hours. The apparatus is then inclined and the paste emptied into a wooden box lined internally with copper sheeting. This paste is then compressed by hydraulic presses in order to give it more consistency, and to expel the air bubbles. The last operation consists in moulding the powder into the form of cord in presses specially constructed for the purpose. Except for the dimensions, the presses employed for small-arm powder are identical with those for big gun powder. In the first the charge for the press is 1 lb. English, and in the second 5 lbs. Small-arm powders when issuing from the presses are rolled on metal drums where they are allowed to dry for three days so as to eliminate any trace of the solvent. When the cartridges are filled, the cord thus obtained is cut by mechanical means to the requisite lengths. The charges are not regulated by weight, but by measuring the lengths, which is more convenient. As regards cordite for heavy guns, which is of greater thickness, they are cut into bundles of a predetermined length immediately on issuing from the presses. The duration of the drying process depends on the thickness of the powder, and is about eight days for powder destined for guns of medium calibre.

Installation of Nitro-Glycerine Powder Factory.—As we have seen, the manufacture of a nitro-glycerine powder is a very delicate and trying operation, both from the point of view of safety in the manipulation and in the quality of the product obtained, necessitating great purity in the original materials. It is then a matter of primary importance that these materials should be manufactured, or at least purified in the establishment where they are employed, so that their composition may be guaranteed. Every powder factory for nitro-glycerine powders

should therefore comprise in the works :—1. The manufacture or purification of the chemical products indispensable for the process: sulphuric acid, nitric acid, glycerine, etc. 2. The preparation of the nitro-celluloses, and the nitro-glycerine. We give below, as example, some description of a factory for Nobel powders at Avigliano, in Italy, one of the best organised in Europe. The Nobel factory of Avigliano was founded in 1872 by a group of Italian and Swiss capitalists, united under the name of the Nobel Dynamite Company, and was at first limited to the production of dynamite, but little by little the manufacture developed and extended so as to include all the new explosives. Since 1889 it has produced the smokeless powders of the Nobel type known as ballistite or filite. The factory is situated 25 kilometres west of Turin, on the right bank of the Dora Riparia, close to the village of Avigliano. It occupies an area of 209,000 square metres, and is surrounded by a continuous wall more than 3 kilometres in length. The establishment numbers 314 roomy buildings connected by a network of railways, and a principal one which joins the main line between Turin and Modane, at the Avigliano station, about 1 kilometre from the works.

Nearly all the chemical products required for the manufacture of the explosives are made at the factory. The shops for the preparation of these products are situated on the plain, whilst those for the production and storage of the explosives are installed on the adjacent hill. These last are light barracks, separated by large spaces, and communication between them is by small passages or covered ways. The establishment is divided into three sections, each sub-divided into a number of offices or workshops.—*First section:* Motive apparatus, water, compressed air, lighting, repairing shops for machinery, works department. *Second section:* The manufacture of chemical products. *Third section:* The manufacture of the explosives.

First Section.—The total H.P. of the motive apparatus is 700, and it is sufficient to work all the machinery of the establishment simultaneously. The power is supplied partly by means of four compound engines, yielding 560-H.P., and 13 steam generators; and partly by four Girard turbines yielding 140-H.P., driven by water from a large canal. Advantage will shortly be taken in these factories of the progress made in recent years in the transmission of power at a distance. There has already been secured 100-H.P. furnished by the Electric Company of Upper Italy, who are at the present time utilising a fall of the Dora Riparia for the distribution of motive power in the whole of the Susa Valley. The necessary water for boilers, washing machines, fire service, drinking purposes, etc., is drawn from the canal of Avigliano by five pumps equal together to the delivery of 216,000 litres per hour, into a large reservoir placed at a height of 34 metres.

Five air compressors, capable of compressing 192 cubic metres to a pressure of five atmospheres per hour, serve to work 37 ammunition hoists for the purpose of transporting the chemical products from the chemical works to the powder factories. The shops are lighted entirely by electricity by 580 incandescent 16-candle-power lamps, and

3 arc lamps of 1,500-candle-power fed by 3 dynamos. There are 24 shops for the repair of machinery.

Second Section.—In this section the necessary chemicals are prepared for the powder; the secondary products and residues are sold to the trade. 1. The sulphuric acid is obtained from the pyrites supplied from the mines of Chialamberto; this mineral, very rich in sulphur and copper, is free from arsenic, and yields a very pure acid much appreciated commercially. The works produce 20,000 kilogrammes of acid per day. 2. The nitric acid is obtained from nitrate of soda, obtained direct from Chili. The installation at Avigliano for the preparation of nitric (azotic) acid is the most important in Europe; it turns out 11,000 kilogrammes of highly concentrated acid per day, used only for explosives, and 13,000 kilogrammes of less concentrated acid, a great part of which is sold to the trade. 3. The glycerine is supplied in a crude state from different firms in Italy, and is subjected to distillation at Avigliano in order to purify and concentrate it. The refiners of the establishment turn out 3,000 kilogrammes of chemically pure and concentrated glycerine every 24 hours. The greater part of this is used in the preparation of nitro-glycerine; the rest is sold. 4. Sulphate of soda and hydrochloric acid are produced for sale, permitting of the use of the great quantity of bisulphate resulting from the manufacture of the nitric acid. 5. The excess of sulphuric acid, which arises when there is an interruption in the manufacture of some explosive, is used in the preparation of superphosphates, which are largely exported abroad. 6. The firm also utilises the copper of the pyrites for the production of sulphate of copper. Finally, amongst other secondary products, of which the yield is intermittent, depending on the demands of trade, are sulphates of iron and of manganese, nitrates of lead and of ammonia, bisulphate of soda, etc.

Third Section. 1. Manufacture of Nitro-Glycerine and Dynamite.—The nitrification of the glycerine by means of concentrated sulphuric and nitric acids is carried out in two large apparatus provided with refrigerators and agitators. The nitro-glycerine, which floats on the surface of the mixture, is decanted and submitted to repeated washings. In this way, after some hours of work, 3,000 kilogrammes of nitro-glycerine are produced per day. A part of this substance is transformed into dynamite; the other part is used in the manufacture of smokeless powder.

2. Manufacture of Nitro-Cellulose.—The washed cotton, which constitutes the original material, is at first submitted to a series of operations in order to dry it completely. The nitrification is effected by a mixture of nitric and sulphuric acid in 16 movable barrels. The nitro-cellulose is afterwards placed in 6 turbines, and subjected to a drying process, in order to extract the greater part of the acid mixture; it is then repeatedly washed and pounded till the cellulose is transformed into a very fine paste. This operation is performed by means of 12 pulping machines. The purification and desiccation of the paste thus obtained is done in a special apparatus, of which the firm possesses the patent; it is then ready

for the manufacture of the smokeless powder. The establishment can turn out 2,600 kilogrammes of this nitro-cellulose daily.

3. Cotton Powder.—This is prepared in a similar way to the nitro-cellulose, but the paste is transformed under great pressure into a white substance easy to work. In the two preceding manufactures powerful aspirators absorb the nitrous fumes which are generated in the apparatus and the presence of which would be dangerous to the health of the workmen. The Nobel factories at Avigliano are fitted to produce 4,000 kilogrammes of smokeless powder daily. The samples are submitted to very minute analysis and trials before being issued to the Service for war purposes. So important and excellently arranged as this establishment is, it yet suffers from one great defect, that it is so close to the frontier and, consequently, not safe from capture by a *coup de main* at the commencement of a campaign. In 1890, therefore, the Italian Government decided to found a military powder factory at Fontana-Lire, in the centre of the country between Rome and Naples, for the manufacture of smokeless powder. This establishment commenced work in 1893, and manufactures the chemical and other original materials for the preparation of this description of powder, but as regards this speciality is only a miniature Avigliano

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The Pyro-Collodion Powder of the Russian Navy.

By G. MAQUIN, Capitaine d'Artillerie.

Professor Mendéléyef, a Russian chemist of very high repute, was deputed by the Russian Admiralty, in 1890, to visit the principal smokeless powder factories in London and Paris, with a view to subsequent experiments in this direction. The result of his enquiries led him to the conclusion that existing powders, owing to different influences during their manufacture, were wanting in uniformity in their qualities. In this state of affairs, one of the first points to which the professor directed his attention was in the composition and production of collodion. He was thus led to the conviction that there existed many species of collodion; as the result of experiments in this substance he discovered a means of obtaining, by varying the ordinary means of procedure, a particular collodion intermediate between gun-cotton (or pyroxyle) and ordinary collodion as regards the quantity of azote it contained, and to which for this reason he gave the name of pyro-collodion. The proportion of azote (nitric acid) for pyroxyle is 13 per cent, pyro-collodion 12·5 per cent., collodion 11·5 per cent. Insoluble in alcohol, this pyro-collodion is soluble in a mixture of alcohol and ether and will gelatinise in it when the quantity of the solvent is small. It can then be made into ribbons or sheets which, when dried, have the appearance of celluloid; it detonates in a closed vessel without residue. It is this substance, of a well-defined nature and composition, which is the base of the new smokeless powder actually employed in the Russian Navy, and the manufacture of which is, at present, a secret. If the formula of the penta-collodion of Eder is $C_{12} H_{15} (NO^2)_{12} O_{10}$, that of pyro-collodion will be $C_{30} H_{38} (NO^2)_{12} O_{23}$, and 100 parts of dry cellulose will give 169·4 parts of the first product

and 166·7 of the second. We believe that the fact of having for a base a well-defined body, that is to say, having always an identical chemical composition, is a very important one in powder manufacture. The regularity of the results, the constant velocities and pressures with equal charges, their progressive variation as the charge varies, are, in fact, the best qualities that can be obtained when the powder remains the same in composition. Now gun-cotton powders cannot possess these qualities in a very high degree, because they contain very often products of inferior nitrification besides the celluloses; from this fact, to obtain results more or less regular with this powder we are obliged to have recourse to mechanical mixture.

Volume of Gas Evolved by Deflagration.—We know that in accordance with the law of Avogadro and Gerhardt it is possible, knowing the complete formulæ of deflagation of a body of which the products of combustion are in the form of gas or vapour, to calculate the relative volume occupied by these products at a given temperature and pressure. In the case of pyro-collodion the formula of decomposition is :—

$$C_{30}\,H_{38}\,N_{12}\,O_{49} = 30\,CO + 19\,H_2O + 6\,N_2$$

$$\text{Weight} = 30 \times 28 + 19 \times 18 + 6 \times 28 = 1{,}350$$

$$\text{Volume of Gas} = 30 \times 2 + 19 \times 2 + 6 \times 2 = 110$$

Whence it results that for 1,350 parts by weight we have 110 by volume. For 1,000 in weight we then have 81·5 in volume, which is expressed thus : V 1,000 = 81·5.

This value V is superior to that corresponding to the most highly nitrated smokeless powder, whether of gun-cotton or nitro-glycerine. It surpasses very considerably that for black powder, which is only equal to about 30. [Here the editor of the *Revue* points out that the volume of gas evolved per kilogramme is maximum not for pyro-collodion but for the minimum nitrification within the limits, which will assure the combustion of the carbon. From this point of view tetra-nitrated cotton would be superior both to pyro-collodion and the penta-nitrated cotton powder of the Navy; but, on the other hand, taking account of the heat disengaged, we recognise that the most nitrated products yield the maximum forces and the most advantageous ballistic properties. We see, however, that the question is much more complex than indicated by the author.]

Degree of Stability.—Pyro-collodion keeps very well. When washed in water under proper conditions it can be heated to 65° C. without suffering alteration (as proved by Abel), not only for 10 to 20 minutes as ordinary gun-cotton, but for hours at a time if the washing in water has been followed by washing in alcohol. As to powder having pyro-collodion as a base, it can be heated to 110° as with the best gun-cotton. With a powder of which the pyro-collodion has been well washed this temperature of 110° has been maintained for 8 hours without any trace of redness on litmus paper. It was decided that the first trials of the pyro-collodion powder should be made in Q.F. guns of 47 millimetres and in the 7·62-millimetre rifle. The trials were therefore commenced by

means of shells furnished with crusher gauges in order to determine the thickness which should be given to the laminæ to reproduce the conditions of force corresponding to that of ordinary powder in guns of these calibres. Flakes of larger dimensions were afterwards tried, and showed that it was easy to regulate the dimension so as to vary the duration of combustion (or more exactly the time required for crushing the gauge) from $\frac{1}{1000}$ to $\frac{1}{50}$ of a second. These trials also brought out prominently the fact that the growth in the duration of combustion was almost exactly proportional to that of the thickness of the laminæ. Now we know that in the other smokeless powders this quality is not so notable, and it is precisely for this reason that the employment of these powders for heavy guns has been so restricted, from the difficulty of finding powders of sufficiently slow combustion. The fact of being able to modify the force of explosion by a simple alteration in the dimensions of the grain of powder employed, and without the addition of any retarding substance, is one of the essential characteristics of the new substance, and opens the possibility of its appropriation for guns of the largest calibre.

The following table shows the results of experiments which have been made by the technical laboratory of the Russian Admiralty by Mr. Smirnoff, and which form the superiority of the new powder. All these results correspond to pressures above 2,000 atmospheres. The charges employed were :—

Gun-cotton -	44 grains.	2 density of charge.
Pyro-collodion	44 „	2 „ „ „
Nitro-glycerine	40 „	1·8 „ „ „

If D be the duration of combustion, that is the time during which the gauge is compressed, and E the thickness of the powder grains, the following table shows that pyro-collodion powder burns slower than the other smokeless powders :—

Pyro-collodion.		—	Nitro-glycerine powder.	Pyro-collo-dion.	—	Gun-cotton powder.	Pyro-collodion (calculated).
E	D Millionths of second.	E	D Millionths of second.	D Millionths of second.	E	D Millionths of second.	D Millionths of second.
Millimetres.		Milli-metres.			Milli-metres.		
0·09	1·2 to 1·5	0·8	2[1]	4·9	0·7	2·7	4·4
0·65 to 0·72	4·0 to 6·1	1·0	2[1]	6·0[1]	1·4	7·0	8 1
2·06	11·4[1]	1·6	3[1]	9·1			
14·00	45·0[1]	3·0	6[1]	16·0[1]			
		5·0	13[1]	26·0[1]			
		5·4	12[1]	27·7			

[1] Approximately.

A comparative study more or less complete was also made of the products of combustion of the different powders. It was proved that

smokeless powders often give evidence of imperfect combustion in their products. For example, in analysing cordite we find:—

Nitro-glycerine -	·57 per cent.	Carbon -	23·3 per cent.
Gun-cotton -	29·07 ,,	Hydrogen -	3·06 ,,
Collodion - -	8·15 ,,	Oxygen -	58·2 ,,
Carb.-hydrogen -	5·1 ,,	Nitric acid	15·1 ,,
Ashes - -	·34 ,,	Ashes -	·34 ,,
Moisture - -	·34 ,,		

Now in cordite in order for all the hydrogen to be converted into water and all the carbon into carbonic oxide 55·5 per cent. of oxygen is necessary, and in order for the hydrogen to be converted into water and all the carbon into carbonic acid 84·8 per cent. of oxygen is required. As cordite only contains 58·2 per cent. of oxygen, it is plain that there must be incomplete combustion in the products, and this experiment has proved.

In the case of ballistite also the product has not enough oxygen for complete combustion. To transform the H and C into water and CO, 52·2 per cent. of oxygen is required and for transformation into water and CO^2 81·4 per cent., whilst ballistite only contains 59·6 per cent. of oxygen. The same can be shown with respect to pyro-collodion.

At the time of these first trials in 1892, laboratory experiments showed that no smokeless powder then in use was entirely satisfactory. Since that time improvements have been sought both from the side of gun-cotton as of the nitro-glycerine powders. But time pressed; further there already existed in Russia gun-cotton powder establishments for arms of small calibres, which was used both in the Army and Navy and for torpedoes. It was therefore decided to continue the studies with a view to improvement in these powders. That this was a fortunate decision Professor Mendéléyef's remark to-day proves:—"There has," he says, "been no discovery since 1892 which has eliminated the defects of nitro-glycerine powders, particularly from the point of view of the erosion to which it gives rise."

Velocities and Pressures.—If V be the initial velocity impressed by a powder charge π to a projectile of weight p for a pressure P, the author estimates that $\frac{V}{P}$ is one of the most important quantities to consider in the comparison of different powders. Further, he says, the greater this value the more advantageous are the ballistic properties, for with equal pressure we get a higher initial velocity. From the point of view of economy it is the live force of the projectile per unit of weight of powder $\frac{p\,V^2}{\pi}$, which plays the principal *rôle*, for it gives us some idea of the expenditure necessary to obtain a certain effect; this quantity is designated hereafter F. Each of these two values corresponds to different qualities of the powder, and we shall have on multiplying them together $R = \frac{p\,V^3}{P\,\pi}$, which in a condensed form gives us an approximate idea of the combined qualities of the powder.

The comparative results of the best gun-cotton powder, and of pyro-collodion with grains of ·25 millimetre thickness and a density of 1·621, in the 7·62-millimetre rifle of length of barrel of 805 millimetres and a weight of bullet of 13·77 grammes are :—

Powder.	π Grammes	P Atmospheres.	V Metres.	$\frac{V}{P}$	F	R	$\frac{V}{\pi}$
Gun-cotton ...	2·38	2500	625	·250	226×10^4	56×10^4	262
Pyro-collodion	2·3	2081	622	·298	231×10^4	69×10^4	270
	2·4	2108	637	·306	232×10^4	70×10^4	265
	2·5	2352	652	·276	233×10^4	65×10^4	260

The last column gives the relation of the initial velocity to the weight of the charge. If all the powder is really burnt in the barrel, this quantity decreases while the charge is increased. On the whole the numbers in the table are in favour of the pyro-collodion powder in particular that it gives the velocities for a less pressure. Experiments were carried out in the 3-pounder 47-millimetre Q.F. gun, the details of which were as follows :—

Length in calibres -	43·57	Weight of projectile	1·506 kilos.
Capacity of chamber	·845 litre	Weight of charge -	717 grammes.
Initial velocity -	600 metres	Pressure - -	2,030 atmos.
		Pressure admissible	2,500 ,,

The experiments commenced in May, 1892, and were continued in 1893. As already mentioned, the thickness of the laminæ had been determined by experiment so as to give approximately the same velocities as the brown powder in use. Three thicknesses were employed successively, six shots with the thinnest, twenty-four with the medium, and seven with the thickest laminæ. The projectile weighed exactly 1·497 kilogrammes. The results obtained are exhibited in the accompanying table, from which it will be seen that as the laminæ increase in thickness $\frac{V}{P}$ increases but F decreases. From a ballistic point of view therefore thick laminæ are to be chosen, whilst from the economical one thin ones are preferable. Practically the choice depends on which of these two conditions predominates.

Experiments with the 3-pounder Gun.

No. of rounds.	π Grammes.	P Atmospheres.	V Metres.	$\frac{V}{P}$	F	R	$\frac{V}{\pi}$
			With Thin Laminæ.				
1	341	2045	697	·340	213×10^4	72×10^4	8·72
1	345	2080	700	·338	213×10^4	72×10^4	8·65
4	350	2147	705	·337	213×10^4	70×10^4	8·60

Experiments with the 3-pounder Gun—contd.

With Medium Laminæ.

1	291	1810	638	·352	191×10^4	67×10^4	8·50
2[1]	341	1945	665	·338	194×10^4	66×10^4	8·31[1]
2	350	1985	691	·347	205×10^4	71×10^4	8·41
2	354	2028	699	·342	205×10^4	70×10^4	8·41
4[1]	358	2012	700	·347	205×10^4	71×10^4	8·31[1]
8	367	2025	710	·349	206×10^4	72×10^4	8·26
2	375	2110	720	·340	208×10^4	71×10^4	8·17

With Thick Laminæ.

1	213	<1500	470	—			
1[1]	277	<1500	518	—			
2[1]	341	1580	621	·393	170×10^4	67×10^4	7·77
3	311	1745	642	·366	181×10^4	66×10^4	8·02

[1] The powder in these cases was not completely dry, it still contained traces of the solvent.

If it be wished to determine the necessary thickness of laminæ to give a velocity the highest possible without exceeding a pressure of 2,100 atmospheres all consideration as to the weight of the charge may be disregarded. The pressure of 2,100 atmospheres corresponds with the thinnest laminæ to $V = 701$ metres and $\pi = 350$ grammes. With the medium thickness $V = 716$ metres and $\pi = 370$ grammes, the thicker laminæ of the two are therefore to be selected. The results of other experiments made with the laminæ of greatest thickness showed that the pressure of 2,100 atmospheres corresponded to about $V = 762$ metres and $\pi = 400$ grammes. We could, therefore, increase the thickness chosen, but in this case we should have to increase the capacity of the powder chamber. If this were done it would appear that velocities of 800 in weight be obtained without exceeding a pressure of 2,300 atmospheres. Similar experiments were carried out with 37[1]-millimetre, 152[1]-millimetre, 228[1]-millimetre, and 304[1]-millimetre guns, and the manufacture of pyro-collodion powder was begun on a large scale in 1893.

The later experiments date from the commencement of 1894, and they have been followed by others in 1895 and 1896, when the manufacture of the pyro-collodion powder was perfected. Unfortunately the results of these trials has not been published by Professor Mendéléyef. According to *Engineering*, on the trials of some plates which took place at Okhta towards the end of 1895, the mean velocity on impact of 6 rounds with the 152-millimetre gun with projectiles weighing 39·5 kilogrammes was 786 metres. Two exceptional rounds give velocities of 864 and 878 metres. The normal velocity at the muzzle actually fixed for this gun was 792 metres. In November, 1896, a gun of 203 millimetres, 45 calibres in length, completely pierced a Krupp plate of hardened steel ·25 metre thick; the velocity of the projectile was 868 metres on impact, and 213 metres

[1] The tabular results given in the original have been omitted in the translation, as they are all of similar character.

on the other side of the plate. About the same time experiments were projected, in which it would be attempted to pierce a Krupp plate ·364 metre thick, with a 250-millimetre projectile weighing 225 kilogrammes, having an impact velocity of 864 metres. The result is not known. The table gives the initial velocities of the principal guns used in the Russian Navy with pyro-collodion powder.

Calibre. Millimetres.	Length in Calibres.	Weight of projectile. Kilogrammes.	Muzzle velocity. Metres.
301	40	322	838
250	45	225	822
120	45	20·4	792
75	45	4·9	853
47	45	1·5	701

Such are the important results obtained by Professor Mendéléyef's pyro-collodion powder.

Experiments with the 3-pounder Gun—contd.

With Medium Laminæ.

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3	311	1745	642	·366	181×10^4	66×10^4	8·02

[1] The powder in these cases was not completely dry, it still contained traces of the solvent.

If it be wished to determine the necessary thickness of laminæ to give a velocity the highest possible without exceeding a pressure of 2,100 atmospheres all consideration as to the weight of the charge may be disregarded. The pressure of 2,100 atmospheres corresponds with the thinnest laminæ to $V = 701$ metres and $\pi = 350$ grammes. With the medium thickness $V = 716$ metres and $\pi = 370$ grammes, the thicker laminæ of the two are therefore to be selected. The results of other experiments made with the laminæ of greatest thickness showed that the pressure of 2,100 atmospheres corresponded to about $V = 762$ metres and $\pi = 400$ grammes. We could, therefore, increase the thickness chosen, but in this case we should have to increase the capacity of the powder chamber. If this were done it would appear that velocities of 800 in weight be obtained without exceeding a pressure of 2,300 atmospheres. Similar experiments were carried out with 37[1]-millimetre, 152[1]-millimetre, 228[1]-millimetre, and 304[1]-millimetre guns, and the manufacture of pyro-collodion powder was begun on a large scale in 1893.

The later experiments date from the commencement of 1894, and they have been followed by others in 1895 and 1896, when the manufacture of the pyro-collodion powder was perfected. Unfortunately the results of these trials has not been published by Professor Mendéléyef. According to *Engineering*,[1] on the trials of some plates which took place at Okhta towards the end of 1895, the mean velocity on impact of 6 rounds with the 152-millimetre gun with projectiles weighing 39·5 kilogrammes was 786 metres. Two exceptional rounds give velocities of 864 and 878 metres. The normal velocity at the muzzle actually fixed for this gun was 792 metres. In November, 1896, a gun of 203 millimetres, 45 calibres in length, completely pierced a Krupp plate of hardened steel ·25 metre thick; the velocity of the projectile was 868 metres on impact, and 213 metres

[1] The tabular results given in the original have been omitted in the translation, as they are all of similar character.

on the other side of the plate. About the same time experiments were projected, in which it would be attempted to pierce a Krupp plate ·364 metre thick, with a 250-millimetre projectile weighing 225 kilogrammes, having an impact velocity of 864 metres. The result is not known. The table gives the initial velocities of the principal guns used in the Russian Navy with pyro-collodion powder.

Calibre. Millimetres.	Length in Calibres.	Weight of projectile. Kilogrammes.	Muzzle velocity. Metres.
301	40	322	838
250	45	225	822
120	45	20·4	792
75	45	4·9	853
47	45	1·5	701

Such are the important results obtained by Professor Mendéléyef's pyro-collodion powder.

NAVAL NOTES.

HOME.—The following are the principal appointments which have been made: Captain—Leslie C. Stuart to "Tauranga." Commanders—A. H. Smith-Dorrien to "Alacrity"; C. W. Winnington-Ingram to "Daphne."

The movements of the Reserve Squadron seem to be still unsettled, but Vice-Admiral Sir C. Domville has hoisted his flag on board the "Alexandra" at Portland in command. The "Terrible," having had her defects made good and made a satisfactory trial, left Portsmouth at 11 a.m. on the 27th ult. for Malta direct, taking out a draft of 250 men for the "Camperdown"; in spite of very rough weather in the Bay of Biscay she averaged 18 knots per hour to Gibraltar, the engines developing 12,500-I.H.P.; from Gibraltar to Malta she averaged 20 to 22 knots, although owing to hot bearings she had to proceed with the port engine alone for some hours, making 14 knots, but she nevertheless arrived at Malta on the 2nd inst., having made the passage in six days, at an average speed of 18 knots; she brings the relieved men of the "Camperdown" to England. The first-class cruiser "Edgar" commissioned at Devonport on the 1st ult., and left Plymouth on the 12th ult. for China with relief crews for the "Daphne," "Pigmy," "Plover," and "Redpole." The "Devastation" left Plymouth on the 18th ult. to take up her duties as port-guard-ship at Gibraltar. The second-class cruisers "Astræa" and "Forte" arrived at Plymouth from the Mediterranean on the 17th ult.; they will pay off at Devonport and Chatham respectively. The first-class cruiser "Blake" arrived at Plymouth on the 29th ult. from the Channel Squadron, and paid off on the 5th inst., her officers and crew turning over to the new first-class cruiser "Niobe." The third-class cruiser "Cordelia" arrived at Portsmouth on the 19th ult., from the North American and West Indian station; she will pay off at that port; her place is to be taken by a sister-ship, the "Comus," which is to be commissioned in January. The first-class cruiser "Blenheim" with the paid-off crew of the "Barfleur" arrived at Plymouth from China on the 7th ult. and paid off at Chatham on the 25th ult. The third-class cruiser "Brisk" commissioned at Chatham on the 10th ult. for service on the China station, and sailed on the 30th ult. for her destination. The third-class cruiser "Scout" arrived at Portsmouth on the 30th ult. from the Mediterranean and will pay off at that port.

Steam Trials.—The first-class cruiser "Argonaut" has commenced her steam trials, and the results of the 30 hours' coal-consumption trial, at 3,600-I.H.P., are as follows:—Draught of water, 24 feet 3 inches forward, 26 feet 3 inches aft; speed of ship, 12·5 knots; steam pressure in boilers, 226 lbs. per square inch; vacuum in condensers, 24·8 starboard, 25·4 port; revolutions per minute, 74·4 starboard, 74·8 port; mean I.H.P., 1,912 starboard, 1,844 port—total, 3,756; consumption of coal, 239,980 lbs., or 2·13 lbs. per I.H.P. per hour.

The new first-class cruiser "Andromeda" has also commenced her trials. The results of her 30 hours' coal-consumption trial were as follows:—Draught of water, 24 feet 2 inches forward and 26 feet 6 inches aft; steam in boilers, 197 lbs.; vacuum in condensers, 25·2 inches starboard and 26 inches port. The mean I.H.P. of the 30 hours was 3,388, with 70·15 revolutions starboard and 68·38 port. The mean speed was 12·9 knots, and the coal consumption worked out at 1·98 lbs. per H.P. per hour.

New War-Sloops.—The new sloops which are to be commenced at Sheerness, when the dock in which the "Condor" and "Rosario" are being built is vacant, are to be named the "Shearwater" and the "Vestal." They will be of a similar type to the "Condor" and "Rosario," their principal dimensions being:—Length, 180 feet; beam, 32 feet 10½ inches; mean load draught, 11 feet 6 inches; displacement, 980 tons. Their engines will be of the triple-expansion

type, and they will be fitted with water-tube boilers. Their machinery is to indicate 1,100-H.P. with natural and 1,400-H.P. with forced draught, with a speed of 12·6 knots and 13·25 knots per hour respectively. Their armament will consist of six 4-inch and four 3-pounder Q.F. guns. Preparations will shortly be commenced for building, in order that there may be no delay in laying down the sloops when the "Condor" and "Rosario" are floated. One of the sloops will be engined by machinery made at Devonport, and fitted by the chief engineer's staff at Sheerness; the machinery of the other will be supplied by contract.

Increase of the Active Lists.—By an Order in Council, dated the 29th November, the future numbers of the under-mentioned ranks upon the Active Lists are to be as follows:—

"Flag-Officers, 80:—		
Admirals of the Fleet	3	
Admirals	12	
Vice-Admirals...	22	
Rear-Admirals	43	
		80
"Captains		245
"Commanders		360
"Lieutenants		1,550"

The rate of increase in the Executive Lists is to be as follows:—

"Flag Officers.—One each year commencing on first day of January, 1899.

"Captains.—Annual increase of four in 1898, five in 1899, five in 1900, and so on in each succeeding three years.

"Commanders.—Six each year, commencing with 1898."

There is also to be a considerable increase in the numbers of the Warrant Officers' Lists, which are to number as follows:—

"Chief Gunners and Boatswains	100
"Chief Carpenters	20
"Gunners and Boatswains	1,150
"Carpenters	240"

Launches.—On the 17th ult., from the same, almost historic, slip at Portsmouth, which has cradled so fine an array of war-vessels within the past twelve years, viz:—the "Trafalgar," the "Vulcan," the "Royal Arthur," the "Prince George," the "Fox," the "Eclipse," the "Gladiator," and the "Canopus"—was successfully launched the mightiest battle-ship, in point of displacement, which the world has yet seen—the "Formidable."

The accompanying illustration (for permission to reproduce which with the following description of the ship we are indebted to the courtesy of the editor of the *Engineer*) shows the various features of the "Formidable," and points out in what respects she differs from earlier vessels of this class; the improvements in protective features, in power of armament, and in coal capacity, as well as in anticipated speed, being very considerable. It is important to notice the points in the engraving from which the various measures of length are taken. The first perpendicular "O" is assumed to be at the spot where the load water-line touches the stem; the last perpendicular corresponds with the aft face of the sternpost. The length over all is measured from ram point to taffrail. The vertical side armour is drawn with shaded full lines; the barbette armour, and athwartship armoured bulkheads, which slope inwards at an angle, thus adding 17 feet fore and aft to each end of the citadel, making it 250 feet long altogether—are drawn and shaded with dotted lines. The thin nickel steel plates, 2 inches in substance, running from the forward end of the 9-inch belt, are shaded more lightly.

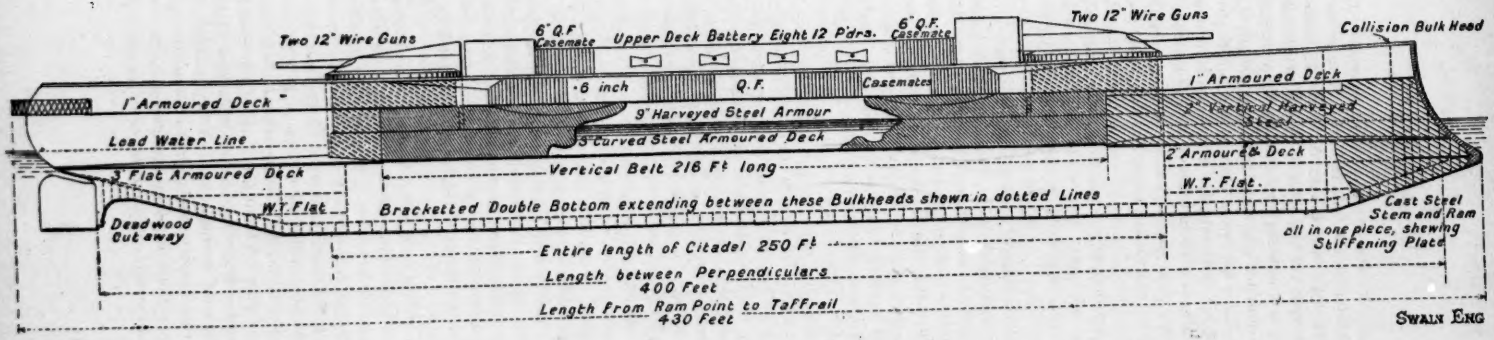
The ram bow of the "Formidable" is greatly modified. Instead of being formed of two steel castings bolted together, and passing down to the forefoot, it is all cast in one piece, and runs from the stem to the ram proper—which is

shaped like a gigantic thimble—and ends there, the vertical and flat keels sloping up at an angle towards it for a distance of about 45 feet, are securely built into it. Into the ram is inserted also the 40-lb. steel stiffening plate, which runs horizontally back to the seventh frame bulkhead, the eighth frame being that where the main collision bulkhead comes. This allows for the driving in of the ram in the event of a mishap to the stem without injuring this important bulkhead. As in the "Canopus," the subsidiary bulkheads which run from the first to the seventh frames will be filled in with cork up to the main deck.

The deadwood aft, as will be seen in the engraving, is cut away altogether; a vertical height of 11 feet being thus removed just forward of the sternpost, which is a solid steel casting descending without any support for the rudder to hang on, and forking out both ways forward and aft beneath the tiller compartment, to support the stern framing. This feature, which is seen in the Japanese battle-ship "Yashima," was dilated upon in a paper read by Mr. Philip Watts, at the spring meeting this year of the Institute of Naval Architects. When associated with the cutting away of the keel forward, it has the effect of facilitating the turning of the ship within a smaller circle in a very marked degree, and thus assists evolutionary movements.

The "Formidable" is one of a class consisting of three vessels building at Portsmouth, Chatham, and Devonport, which may be described as improved "Majestics." They were designed by Sir William H. White. Their principal dimensions, etc., are as follows:—Length, between perpendiculars, 400 feet; length over all, about 430 feet; beam, extreme, 75 feet; displacement, 15,000 tons, or 16,200 tons if coaled to full bunker capacity; mean draught, 26 feet 9 inches at normal displacement, or 28 feet 5 inches if coaled to full bunker capacity; speed, 18 knots; I.H.P., 15,000. She will be propelled by twin screws, each screw being actuated by a set of triple-expansion engines of 7,500-I.H.P. The steam will be supplied by twenty independent water-tube boilers of the Belleville type, fitted with all the latest improvements, and with the economisers as supplied to the "Diadem," and capable of supplying steam at 300 lbs. pressure, which will be reduced at the engines to 250 lbs. pressure. The engines and boilers are being built by the Earle's Shipbuilding and Engineering Company, Limited, Hull. The amount of coal carried at the normal draught of 26 feet 9 inches is 900 tons, although provision is made for the storage of 2,100 tons altogether. It is calculated that the extra 1,200 tons would bring the ship down 1 foot 8 inches, at the rate of 60 tons per inch. A special feature of this ship is that the lower bunkers can be coaled direct, independently of the upper bunkers. To those who are acquainted with the circumstances attendant on coaling in an ordinary ship, when the coal rains down in a shower through the upper bunkers into the lower ones, enveloping the trimmers with clouds of coal dust, the importance of this modification will be at once recognisable.

The armoured protection is arranged on somewhat similar lines to those obtaining on the "Canopus" and her sister ships. The vertical side armour of the "Formidable" is, however, 50 per cent. thicker, being 9 inches in substance over a depth of 15 feet; and a length of 216 feet, the extent of the armoured citadel being, as before stated, further increased by the diagonal armoured bulkheads up to a total of 250 feet. The steel armour will all be treated by the improved Harveyizing process. The power of resisting the penetration of projectiles will therefore be very great in the case of the 9-inch belt. To the vertical armour must be added the thickness diagonally of the armoured deck slopes. This would be 4½ inches, giving a total of 13½ inches. Now carburised armour plates have a resisting power equivalent to 2·6 of wrought iron, thus the sides of the "Formidable" in the way of the armoured citadel are invulnerable to any projectile which cannot pierce, say, at 2,000 yards, a thickness of 35·1 inches of wrought iron; and there are few guns being mounted now which can throw


Two 12" Wire Guns
6" Q.F. Casemate
Upper Deck Battery Eight 12 P'drs.
6" Q.F. Casemate
Two 12" Wire Guns
Collision Bulk Head
1" Armoured Deck
6 inch
Q.F.
Casemates
1" Armoured Deck
9" Harveyed Steel Armour
3" Vertical Harveyed Steel
Lead Water Line
3" Curved Steel Armoured Deck
2" Armoured Deck
3" Flat Armoured Deck
Vertical Belt 216 Ft long
W.T. Flat.
W.T. Flat
Bracketted Double Bottom extending between these Bulkheads shewn in dotted Lines
Cast Steel Stem and Ram all in one piece, shewing Stiffening Plate
Deadwood Cut away
Entire length of Citadel 250 Ft
Length between Perpendiculars 400 Feet
Length From Ram Point to Taffrail 430 Feet
SWAIN ENG

"THE ENGINEER"

[Reproduced by permission.]

PROFILE OF H.M.S. "FORMIDABLE," SHOWING DISPOSITION OF ARMOUR.

such a missile effectively at this range. Very frequently the muzzle or initial power of impact of a projectile is confused with that of its power at ordinary fighting range. In these days vessels do not steam up alongside of the enemy in going into action—the risk is too great. The armoured bulkheads of the "Formidable," varying in thickness from 9 inches to 12 inches, are fitted joining the ends of the vertical side armour, thus forming a complete belt round the vital portions of the vessel. There are two protective decks, as shown in the engraving, one being of the now usual turtle-backed shape, on which the armour rests all along the edges, and formed of 2-inch steel plating on the flat portion forward while on the crown of the turtle back, the slopes of the turtle back, and all the after flat part of the deck towards the stem, its thickness is increased to 3 inches. This is an important change; hitherto the after portion of a battle-ship's below deck vitals have been insufficiently covered up. The second armoured deck is actually the main deck, and has a protection of 1-inch of steel all over. There is thus practically an armoured cofferdam extending throughout the whole of the citadel space.

The main armament consists of four 12-inch breech-loading wire guns of a new and improved type, mounted in pairs, two firing forward and two aft. They are protected by a stout hood or shield—as shown in the drawing—8 inches in thickness, whilst the hydraulic mechanism and machinery is protected by a circular armoured redoubt or barbette, the thickness of the armour being 12 inches. Alternative hand gear is provided for working the guns, the breeches of which are opened and closed by hand. The auxiliary armament is formed principally by twelve 6-inch Q.F. guns of an entirely new type, eight being on the main deck, four of which can be fired axially forward and aft in a line with the keel, by the aid of sponsoned ports, and four being on the upper deck in corner casemates, capable of being trained directly forward or aft in the same way. Thus there are in all four 6-inch Q.F. guns which bear axially forward, and four which bear axially aft for end-on fire. These 6-inch guns are all enclosed in casemates, having 6-inch shields outside and 2-inch inner walls and doors—all of Harveyized steel. The ammunition is sent up from ammunition passages beneath the lower armoured deck, through armoured tubes leading direct into each casemate. It is therefore under protection from the time that it leaves the magazine.

In addition, sixteen 12-pounder Q.F. guns will be mounted on board, eight on the main deck along the bows, beam, and quarters, and eight in a covered-in battery on the upper deck. Two 12-pounder 8-cwt. guns for boat and field purposes have also an alternative mounting gear arranged, so that they may be fired over the forward breastwork, making eighteen 12-pounder Q.F. guns altogether. In the two fighting-tops six 3-pounder Hotchkiss guns will be mounted on circular railways, for protection against torpedo-boat attacks. There are also eight Maxim guns to be mounted on the boat deck and superstructure. Four submerged torpedo-tubes 18 inches in diameter will be fitted, two being forward and two aft.

A conspicuous feature of this ship is the formidable cast-steel ram, to which allusion has already been made. This casting weighs by itself over 30 tons, and as a protection to the ship whilst using the ram, the sides forward are covered to a great extent with 2-inch nickel-steel plating in addition to the ordinary skin plating of about $\frac{3}{4}$ inch in thickness. This would correspond to about 7 inches of ordinary wrought-iron plates, and stiffens the bows of the vessel enormously, independently of the protection which it affords against medium-sized shell fire. The structure of the bows of the "Formidable," taking armoured deck, 2 inches thick, and stiffening plate of similar substances, skin and nickel steel armour-plates, framing, bulkheads, and breastworks into consideration, appears well designed to prevent any serious injury arising from the use of the ram.

When completed and ready for hoisting the pennant, the complement of the "Formidable" will be 789 men, if used as a flag-ship, or about 40 more than the

complement of the "Majestic." She will be fitted with two steel masts, each furnished with one military fighting-top, and with a search-light platform on the main topmast; a long-distance semaphore for signalling at sea will also be employed. This semaphore will be about 160 feet above the level of the water-line. The masts are provided with three derricks, two forward and one on the mainmast. These derricks, primarily fitted for hoisting out the boats, will be of great utility when coaling.

The boats include four steamboats—two 56 feet, and two 40 feet in length—and fourteen sailing and pulling boats, ranging from a 42-foot sailing launch to a small dinghy. The two larger boats are capable of steaming about 13·5 knots per hour, and are fitted with torpedo-dropping apparatus. They will also act as scouts whilst the parent ship is in harbour.

Three independent sets of dynamos and engines are required to light the ship and work the electric-motor fans and the search-lights. Every compartment, except the double bottom, etc., will be efficiently lighted by incandescent lamps. Colomb's lights are fitted for use when the dynamos are not running.

Ventilation will be secured by the use of motor fans outside the boiler and engine-room spaces, and by steam fans in these rooms. This plan secures a much cooler temperature in the outside spaces. There will be also a complete installation of electric bells, and voice-pipes communicating with "exchanges" on all decks. In addition to these, loud-speaking telephones will be fitted at important positions.

The ship has been built under the supervision of Mr. Young, assistant constructor in the dockyard, acting under the instruction of Mr. Beatin, constructor, and Mr. J. Yates, chief constructor at Portsmouth. Her launching weight was 5,000 tons.

The quantity of ammunition which will be maintained in the magazines on board, independently of that for saluting purposes and machine guns, will be no less than 12,000 rounds, which would enable the ship to sustain consecutive actions, under ordinary rapidity of fire, for about four hours. Judging, however, by the slow exhaustion of ammunition which took place at Santiago, this time might be considerably extended.—*Engineer.*

As stated above, the "Formidable" will be armed with the new Vickers-Maxim guns, some details of which may be of interest. The 12-inch guns weigh 50 tons, or 4 tons heavier than those mounted in the "Majestic" class, and they have a muzzle energy of 44,575 foot-tons with an initial velocity of 2,612 foot-seconds, as against only 33,020 foot-tons muzzle energy with an initial velocity of 2,367 foot-seconds of the older pattern gun. The 6-inch Q.F. guns are 7 cwt. heavier than those of the "Majestic," with a muzzle energy of 5,540 foot-tons and an initial velocity of 2,756 foot-seconds, as against 2,457 muzzle energy and 2,200 foot-seconds initial velocity of the older guns; while various improvements have been introduced into the mountings and fittings. The total muzzle energy of the "Formidable's" guns will be 222,280 foot-tons as against 172,352 foot-tons of the "Majestic" and sisters.

The gun-boat "Bramble" was launched on the 26th ult. from the yard of Messrs. W. H. Potter and Sons at Liverpool. She is one of four vessels of the "Thistle" class, two of which are being built by Messrs. Potter, and two on the Clyde. The "Bramble's" length between perpendiculars is 180 feet, and over all 187 feet 6 inches, with 33 feet beam. At loaded draught of 8 feet she will have a displacement of 710 tons. She will be armed with two 4-inch Q.F. guns, one on the forecastle and the other on the main deck aft; two 12-pounder Q.F. guns, one on each bow, under the forecastle, and a similar gun on each side amidships. She is also fitted with ten ·45-inch Maxims, three on each side of the vessel on the main deck and two in each of the two military fighting-tops. Accommodation is provided for officers and crew of 70. She has two sets of triple-expansion engines with an I.H.P. of 1,300.

Naval Courts-Martial.—A Parliamentary paper lately issued gives the returns of the number of courts-martial held, and summary punishments inflicted in the Navy during the year 1897. From this it appears that the number of persons tried by courts-martial was 154, of whom 75 were of the seamen and 36 of the non-seamen class, 8 boys, and 35 Marines; but, of a total of 333 offences against discipline and offences punishable by ordinary law, there were 97 cases of striking and attempting to strike a superior officer, 25 cases of using threatening language to a superior officer, 52 cases of wilful disobedience, and 35 cases of behaving with contempt to a superior officer. 87 of the men tried and convicted were sentenced to imprisonment and dismissal, and 57 to imprisonment with hard labour. One man was sentenced to penal servitude, afterwards modified to imprisonment with dismissal. Among Marines serving at head-quarters and the depôt, Walmer, there were 278 courts-martial, and a total of 413 offences, including 57 cases of violence to superiors and insubordination, and 238 of the men were sentenced to imprisonment with or without hard labour, and 23 to be discharged with ignominy. A comparison of last year's offences against superior authority and also of drunkenness and desertion punished by courts-martial with the returns for 1887 shows that, allowing for the great increase in the Navy, during the past ten years, the number of courts-martial is relatively less; but the number of cases of striking or attempting to strike superiors is on the increase among seamen and Marines afloat. In 1887, when 51,353 seamen and Marines were borne on the books, 149 men were tried by courts-martial for all offences, and there were 45 cases of striking or attempting to strike superiors; while last year, with 82,241 men on the books, the totals were respectively 154 and 97. Among Marines on shore there has been a steady increase both in the numbers tried by courts-martial and offences against authority and desertion, although the numbers borne have only increased from 5,486 in 1887 to 6,585 last year. Thus in the course of the decade the number of men tried by courts-martial for all offences has increased from 151 to 278, cases of violence to superiors and insubordination from 30 to 57, disobedience from 10 to 18, and desertion from 20 to 56. The only improvement shown is in the cases of drunkenness, which have fallen from 13 to 4. The total number of summary punishments awarded during 1897 on men afloat was 89,648, with 82,241 borne on the books, as against 49,643 in 1887, with 51,353 borne; and on Marines on shore 2,883, with 6,585 borne, compared with 2,352, with 5,486 borne ten years ago.—*Times.*

FRANCE.—The following are the principal promotions and appointments which have been made: Rear-Admiral—L. A. Caillard to command of Coast-Defence Squadron at Toulon. Capitaines de Vaisseau—L. A. Caillard to Rear-Admiral; F. J. Pissère to "Amiral-Duperré"; L. E. Lieutard to "Couronne"; C. L. Legrand to "Caïman"; J. A. Ingouf to "Valmy"; L. G. de Marolles to "D'Entrecasteaux." Capitaines de Frégate—L. G. de Marolles to Capitaine de Vaisseau; R. Duval to "Papin"; A. T. de la Motte du Portail to "Kersaint"; K. A. Calloch de Kérillis to be Chief of the Staff to Rear-Admiral Godin, commanding the Training Squadron in the Mediterranean.—*Le Journal Officiel de la Republique Française.*

The Coast-Defence Squadron.—Rear-Admiral Caillard has been appointed to the command of the newly-formed Coast-defence Squadron, which will be composed of the five following coast-defence battle-ships:—"Amiral-Tréhouart," "Bouvines," "Jemmapes," "Valmy," "Caïman," to which the "Indomptable" and "Terrible" will be added as soon as their repairs are completed. Rear-Admiral Caillard, who was promoted on the 29th October last, is the youngest officer of his rank on the list, being only 52 years old. He bears a high reputation as a skilful officer and good tactician, and belongs to the so-called young school of the Navy, to which Vice-Admirals Fournier and Gervais also belong.

His nomination to this important command shows that the Minister of Marine is carrying out his previously expressed intention of only appointing young officers to the command of the sea-going squadrons.

Steam Trials.—The new first-class cruiser "D'Entrecasteaux" has recommenced her trials. With the engines developing 13,000-I.H.P. a mean speed of 19·1 knots was maintained, in spite of a strong wind and rough sea; it is therefore confidently expected that under more favourable conditions a speed of over 20 knots will be reached.

The new torpilleur-de-haute-mer "Cyclone" has made a very satisfactory full-speed trial, a mean speed of 30 knots having been attained. Five other torpedo-boats of the same type have been laid down this year, viz., the "Sirocco," "Mistral," "Simoun," "Typhon," and "Trombe," while a sixth, to be called the "Audacieux," is to be soon commenced.

The new torpedo-aviso "Dunois" having completed her preliminary trials successfully, has now commenced her final ones, the difficulty with her feed supply having been overcome; with the engines developing 3,600-I.H.P. the mean speed realised was 19·3 knots, the coal consumption per H.P. per hour not exceeding 725 grammes.

Launch.—The new torpedo-aviso "La Hire," a sister-ship to the "Dunois," was launched at Cherbourg on the 3rd ult. Her dimensions are as follows:—Length, 78 metres (257 feet); beam, 8·50 metres (28 feet); and with a draught of 12 feet aft she will have a displacement of 896 tons. Her engines are of the vertical triple-expansion type, driving two propellers to develop 6,400-I.H.P., giving an estimated full speed of 23 knots; while her coal stowage of 137 tons will give a radius of action at 10 knots of 5,000 miles. She will carry six 65-millimetre (2½-inch) and six 47-millimetre (1¾-inch) Q.F. guns, and her cost is 3,157,050 francs.

Changes in the Défense-Mobile.—On the 1st November the torpilleurs-de-haute-mer "Mousquetaire," "Dragon," and "Agile," with the first-class torpedo-boats 191 and 180, were commissioned at Toulon. The "Mousquetaire" and "Dragon" will be stationed at Bizerta, the "Agile" at Oran, and Nos. 191 and 180 at Ajaccio. The small flotilla will proceed in company as far as Ajaccio.

The torpilleur-de-haute-mer "Grondeur," with five first-class torpedo-boats, Nos. 153, 154, 171, 194, and 205, have been commissioned, and will proceed to Dunkirk to reinforce the *Défense-Mobile* at that station. So as to insure the efficient conservation of the torpedo-boats of the *Défense-Mobile* their number will be diminished by 12. A post of the *Défense-Mobile* is to be established at Saint-Servan; and at Cherbourg, Brest, and Toulon the sea-going torpedo-boats in reserve are to be attached to the *Défense-Mobile* of those ports.

Work in the Dockyards.—Work on the new battle-ship "Iéna" at Brest is being pushed on with great rapidity, the plates of the armour deck are in place, and some of the armour for her side has already arrived. Preparations are being hurried forward for the laying down of the new battle-ship "Suffren" on the slip from which the "Iéna" was lately launched; it is hoped that she will be ready to take the water even more rapidly than her predecessor on the slip did.

At Toulon every effort is being made to complete the new armoured cruiser "Jeanne d'Arc," as well as the cruiser-corsair "Châteaurenault," which is to have a speed of 23 knots under forced draught and a sea-speed of 21 knots.

The coast-defence ironclad "Indomptable," now under reconstruction, is to carry six instead of four 4-inch Q.F. guns, protected by 2-inch shields. The two big 75-ton barbette guns are to be replaced by two 10·8-inch Canet 1891 model in turrets instead of barbettes. By thus lightening her it is hoped that some of the armour-belt may come above water; hitherto it has been all submerged. Two torpedo-tubes will be removed. The "Caïman" will be similarly treated, but the "Terrible" will have 12-inch guns on the old mountings of the present 13-inch.

New Armoured Cruisers.—In the shipbuilding programme of 1898 were six armoured cruisers of 9,517 tons and three ("Desaix," "Kléber," "Dupleix") of 7,700 tons. The "Montcalm," "Dupetit-Thouars," and "Gueydon," of the larger type, are to be built of the displacement intended, but it has been decided that the other cruisers of the class—the "Gloire," "Condé," and "Sully"—shall be increased to about 10,000 tons. The added weight will allow the thinner plating above the 6-inch side armour to be increased to 5 inches, with some strengthening of the armoured and splinter-proof decks, and the addition of armouring between the casemates for the 6·4-inch guns and the armour belt, thus protecting the guns from shells entering below the casemates. Four of these guns are to be so placed, and four others in closed turrets on the spar deck, while the two heavier guns (7·6-inch) will be in turrets fore and aft.—*Le Yacht* and *Le Temps*.

The French Naval Manœuvres.—We have not given this year any detailed account of the French naval manœuvres, because, however instructive they may have been for the French squadron in the Mediterranean and Channel, they present no points of general interest for ourselves.

The first period of the manœuvres in the Mediterranean, which lasted from the 5th to the 8th July, was spent in experimenting with the Temperley apparatus for coaling ships, torpedo-boat raids on the squadron by the boats of the *Défense-Mobile*, ballooning operations from the "Foudre," and tactical exercises, the head-quarters of the fleet being in the roadstead of Salins d'Hyères. The first-class battle-ship "Marceau" was ordered, during bad weather, to enter the small and narrow bay of Bonifacio, which is little more than a fissure in the rocks, 600 feet wide, and about three-quarters of a mile long; this she successfully did, and there is now no doubt that Bonifacio will be made a secondary base for watching the Straits and the Italian station of Maddalena on the opposite side, as it offers an absolute shelter.

On the 10th July Vice-Admiral Humann took the whole fleet, consisting of ten battle-ships, nine cruisers, and several torpedo-vessels—in all twenty-seven vessels—through the canal into the great lake of Biserta, where they moored, and there is no doubt that the French Government intend to turn this harbour into a base of first-rate importance.

For the third part of the manœuvres the fleet was formed into three divisions, A, B, and C, the following being the theme of operations:—An enemy's squadron B, coming from the eastern part of the Mediterranean, either by the south of Sardinia, the Straits of Bonifacio, or between Cape Corso and the island of Capraja, was to threaten the coast of Provence, Algeria, or Tunis. The attacking force B was composed of the battle-ships "Amiral-Duperré," "Amiral-Baudin," and "Formidable," with the torpedo-boat "Orage," under the command of Rear-Admiral Godin. The defending fleet A was composed of the battle-ships "Brennus," "Jauréguiberry," "Carnot," "Magenta," "Neptune," "Marceau," and "Charles-Martel"; and of the light squadron C, consisting of the cruisers "Latouche-Tréville," "Chanzy," "Cassard," "D'Assas," "Lalande," "Lavoisier," "Milan," "Condor," and "Foudre," with eight torpedo-vessels, assisted by the *Défenses-Mobiles* of Algeria, Tunis, Corsica, and Toulon. The whole defending force was under the command of Vice-Admiral Humann, and the light squadron C was placed under the orders of Rear-Admiral Dieulouard. The enemy had to remain twelve hours before the place attacked, in order to be counted as the winner. Hostilities were declared on July 20th, at mid-day, and, by the rules, B was not allowed to come by the southern passage after 8 a.m. on the following day. The enemy not having appeared between Sardinia and Galita by the hour named, Vice-Admiral Humann immediately proceeded northward, keeping to the west of Sardinia, with his cruising squadron ahead, but in touch with him. The enemy passed through the Straits of Bonifacio at 3 p.m. on the 21st, but he was observed by the boats of the *Défense-Mobile*,

who kept him in sight and also warned the signal stations. When the leading cruiser reached Asinara, off the north end of Sardinia, she received intelligence of the course taken by the enemy, and got in touch with the torpedo-boats following him. The information was communicated to the Commander-in-Chief through the line of cruisers, extended at 10-mile distances, and the course to be followed indicated by rockets, with the result that on the morning of the 22nd the two hostile squadrons were only 30 miles apart, and the attack of the enemy was foiled. Vice-Admiral Humann warmly complimented Rear-Admiral Dieulouard upon the efficiency of the scouting and signalling of his squadron of cruisers; touch with the enemy was soon gained, and once gained was never lost.

The principal operations in the Channel consisted of an attack by the fleet on Brest, with the object of testing the improvements made in the defence system, and then of landing a strong force of Marines near Douarnenez in face of a strong opposing force on land.

RUSSIA.—The following appointments have been made: Rear-Admiral—Bezobragov to be Chief of the Staff at Kronstadt, vice Rear-Admiral Vesëlyi. Captains—Ball from the first-class cruiser "Pamiat Merkuria" to the battle-ship "Sinope"; Vishnevetski to the "Pamiat Merkuria"; Tikhmeniov to the training-ship "Berezan"; Rimski-Korsakov from the "Admiral-General Apraxin" to the Imperial Yacht "Standart." Lieutenant—Polis, Naval *Attaché* in Germany.

Steam Trials.—The new second-class battle-ship "Rostislav," belonging to the Black Sea Fleet, had a six hours' trial of her engines, with the result that steam was maintained at a fairly even pressure of 125 lbs. to the square inch, the boilers being heated with naphtha under mechanical pulverisation. The engines gave on the average 90 revolutions, and worked fully up to the conditions specified in the contract. The mean speed attained was 15·6 knots. Diagrams taken gave an average of 8,700-I.H.P., or slightly above the contract of 8,500. There was a slight smoke from the funnels all the time, which indicated imperfect combustion.

The following shows the results given by the engines of the new first-class battle-ship "Petropavlovsk" this year as compared with last year:—

	1897.	*1898.*
Draught—Bow	23 feet 7 inches	24 feet 4 inches
Do. Stern	25 feet 5 inches	25 feet 4½ inches
Do. Amidships	24 feet 6 inches	25 feet 4½ inches
Displacement	10,404 tons	10,890 tons
Area of hold	1,549 square feet	1,610 square feet
Mean speed	16·84 knots	16·38 knots
I.H.P.—Port Engine	5,439·83	5,587·57
Do. Starboard Do. ...	4,976·62	5,625·49
Gross total I.H.P. ...	10,416·45	11,213·06
Number of revolutions ...	84	84
Pressure of steam	120	120

The following are the results of the trials of the engines of the new coast-defence battle-ship "Admiral-General Apraxin":—The war-ship made four runs on the measured mile, and the mean speed realised was 15·07 knots. During a seven hours continuous run of the engines at full power no interruption in the regularity of the working was observed. During the trials nine diagrams were taken, and these indicate that the engines on this occasion realised far more than the 5,000-H.P. required by the contract. The I.H.P., as shown by the ninth diagram, was as follows:—Port—High-pressure cylinder, 806·17; intermediate, 997·80; low, 1,028·60—total, 2,832·57. Starboard—High-pressure cylinder, 817·63; intermediate, 1,026·78; low, 1,080·42—total, 2,924·83. The number of revolutions of the port engine was 123 and the pressure of steam, 128·4 lbs.; of the starboard engine,

revolutions, 124; pressure of steam, 133·2 lbs. The grand total I.H.P. was 5,757·40. At the first trial the I.H.P. fell short of that contracted for, and the contractors at the Franco-Russian Works became subject to a fine of £2,920. The makers attribute the deficiency of the I.H.P. to the incapacity of the stokers.

The first-class armoured cruiser "Hertsog Edinburgski" has made her trials with the new screw and developed an increased speed on the measured mile of 1·31 knots. The screw is similar to that designed for the coast-defence battle-ship "General-Admiral Apraxin" by Inspector of Machinery Afonasiev.

Trials have been made on board the cruiser "Asia" of the new French briquettes. They are made at Rostov, of small coal from the Don collieries, mixed with 10 per cent. of naphtha. The results were very satisfactory as regards expenditure and maintenance of heat. They were tried at 45, 55, and 60 revolutions, and the expenditure per hour at the second of these numbers was 31¼ poods (about 10½ cwt.), whereas the ordinary Don coal burns at the rate of 15 cwt. At 60 revolutions the expenditure was 16½ cwt., instead of 18¾.

The new first-class battle-ship "Poltava" has tried her engines, the results of a 12 hours' trip being an average speed of 16·29 knots. She gave an I.H.P. of 11,000 as against 10,600 estimated, her displacement being 11,000 tons; her screws have four fans, with a diameter of 17 feet, and a stroke of 24 feet.

Dockyard Work.—The old turret-ship "Piotr Veliki" is now in process of being remodelled. Her guns are to be replaced by 12-inch of a new pattern, 40 calibres in length. The armour of her turrets is also to be replaced by some of the latest pattern.

The new first-class battle-ship "Prince Potemkin Tavrichesti" is being pushed on rapidly. All the under-water portion of her is now complete. The ceremony of affixing a silver plate to her vertical keel was performed by Vice-Admiral Tyrtov, early in October at Nicolaiev. Her engines and boilers are being constructed at the same place.

The four new boilers made by the Baltic Works for the first-class armoured cruiser "Admiral Nakhimov" have been sent to Kronstadt, and are to be fitted while the vessel is in dock. It is hoped that the remainder will be ready before the winter sets in. The main ventilating shaft that supplies air to the engine-rooms and stokeholds is to be dispensed with altogether and replaced by four turbines, which are to be worked by an electro-motor. New electro-motors are also to be supplied to the cruiser in place of the obsolete existing ones. As all the turbines require to be worked by electricity and the amount necessary is estimated at 306,000 volts, instead of the steam dynamos giving 320 and 240 ampères as originally intended, the ship will be supplied with four dynamos giving 640 ampères each, and two giving 240 each.

Work is being pushed on on the new first-class cruiser "Gromoboi," so that she may be launched next spring, and it is hoped that she will be ready for sea a few months later.

The boilers of the old monitor "Admiral Lazarev" are in process of being replaced by new ones.

The new first-class battle-ship "Sevastopol" has been taken into the Alexandrovski Dock, where she will probably be laid up throughout the winter, being warmed by steam from two steam boilers carried through specially-constructed conducting pipes.

Torpedo-Vessels and Boats—The new torpedo-vessels "Yastreb" and "Nyrok," of the "Sokol" type, under construction at the Ijor Government Yard, have been launched, and their engines are in process of being fitted. They will be tried at Kronstadt early in the spring, if the boilers, which are to be supplied by the Baltic Works, are ready in time.

The torpedo-boats Nos. 129 and 130, the last of those of the "Pernov" type ordered, are finished, and will be sent to Kronstadt for trial early in the spring. They are to use Mazut (patent fuel) with mechanical pulverisation, and the necessary fittings are to be completed during the winter.

Two new steam-launches of 34 feet in length have been completed by the Baltic Works, and are to be despatched to Kronstadt as tenders to the first-class cruiser "Vladimir Monomakh."

The Creighton Works at Abo, when the destroyers "Korshun" and "Yastreb" are finished, as they will be shortly, will proceed with the construction of two torpedo-cruisers of the type of the "Abrek," of 400 tons each. Three destroyers of the same type will be taken in hand by the Ijor Government Yard.

It appears that the torpedo-vessels Nos. 136 and 138, built on the "Pernov" type, have many of the same defects as that vessel, more especially in regard to the fitting of the engines.

The type adopted for destroyers is that of the "Sokol," and at present sixteen such are in process of construction, seven at the Ijor Works, two at Creighton's, four at Elbing, and three at Toulon. They are all to have a speed of from 26 to 27 knots, and are to be completed by the spring of 1900.

At Revel the construction of a new dry dock for torpedo-boats is in progress. The canal which runs across the harbour and the basin will be deepened for the purpose.

Armour-plates.—At the Ijor Government Works at Kolpino, the conversion of the machinery for producing armour plates, similar to that employed in the Krupp method, is in progress. It is hoped that before long they will be in a position to produce as good work as any that can be done abroad. At an early date it is proposed to establish a factory for the production of steel tubes cast in one piece for water-tube boilers. The necessary machinery and plant are to be ordered in England. Two new Siemens-Martin furnaces for steel casting are also to be established.

It is intended to apply patent fuel extensively both to these and other furnaces. The management of the work is to be entrusted to Nobel Bros., who are engaged in experiments with such fuel. Electricity is also being largely employed at the Ijor Works, and a central storage of 700-H.P. is in process of construction.

New Naphtha Feeder.—Engineer-Mechanic Stupin has invented a new automatic naphtha feeder, the chief advantage of which is that it permits of complete regulation which there is not with the present force-pipes. According to all accounts it has given excellent results. The plans for the use of naphtha fuel on board the gun-vessel "Kubanets" and battle-ship "Ekaterina II," both of which have Belleville boilers, were prepared by M. Stupin.

Cost of Fleet.—The cost of the Russian fleet at home and abroad is in all 11,514,230 roubles, which is divided among the various ports as follows:—

Kronstadt	2,224,531
St. Petersburg	252,228
Peterhof	20,767
Revel	118,293
Sveaborg	29,802
Libau	9,557
Archangel	45,150
Total for—Baltic and White Seas	2,700,328
,, Black Sea	1,863,874
,, Caspian flotilla	189,773
,, Siberian ,, ...	492,380
Pay of voluntarily enlisted men	285,389
Ships in foreign waters	5,982,486
A grand total of	11,514,230

Exploration.—Doctor Slinnin, who was attached to the Okhotsk-Kamchatka expedition as naturalist, spent the summer and autumn of 1896 in exploring round Port Ayan and made his way from thence to Petropavlovsk during the early winter on a sledge drawn by dogs over the "tundras," a distance of 400 to 500 versts,

often having to sleep on the snow or spend whole days in one of the nomads' tents from sheer inability to get forward. On one occasion his Cossack attendant narrowly escaped being frozen to death, and he himself had his hands badly swollen, while on another the sledge with the dogs and driver fell into a hole where the river had thawed owing to the darkness. Having lost his dogs from famine, he had to make his way on foot across a difficult and dangerous mountain chain to the eastern coast, returning the same way to the western. He then explored all the villages of western Kamchatka, and it was not till April, when the rivers thawed and the snow melted, that he succeeded at length in making his way to Petropavlovsk. In June, having recovered from an attack of dropsy, he went up the river Kamchatka during a heavy flood as far as the village of Klicehevski, and from thence to Yegornia. He then crossed the Stolbovia "tundra" and the Kamchatka ranges on horseback to the river Siedanka, and went down that river to its mouth. He next accompanied the chief of the expedition to Gijiga in search of gold. He made extensive zoological, botanical, geological, and ethnographical collections, and made meteorological observations throughout the country.

The Nakhimov Memorial.—The 30th November being the anniversary of the battle of Sinope, a memorial to Admiral Nakhimov, the hero of that and the defence of Sevastopol, was unveiled in the presence of the Emperor. He was killed, as may be remembered, at the Malakov, the news of his fatal wound causing much consternation and sorrow in the place, as well as among his own sailors. He had just been urged by the commandant not to expose himself so in watching the enemy's batteries, and to go with him to the Vespers, to which he replied, "Very well. Directly, directly!" when a ball struck him on the temple. The people crowded to the hospital on the northern side to enquire for him, while his staff stood weeping round him as the surgeons attended to the wound. Next day was the day of his Patron Saint, but at nightfall the toll of the church bells proclaimed that he was no more. He was buried with the flag of the "Empress Maria," his flag-ship at Sinope, over the coffin. He had also distinguished himself at Navarino.

The site of the memorial, opposite the Marine Institute, was chosen by the late Emperor. The colossal statue, in bronze, and the bas-reliefs, are from the plans by Lieut.-General Vilderling, and are the work of the academician Shróder. The pedestal is of Crimean granite. His cap is pushed back sailor fashion, and he wears the sword of Osman Pasha, taken by him at Sinope; a telescope is in his hand.

Libau and Port Arthur.—The first-class battle-ship "Petropavlovsk," the coast-defence battle-ship "Admiral-General Apraxin," and the first-class armoured gun-boat "Khrabry" are to be sent into winter quarters in Libau Harbour, where the construction of two new docks is now being completed, one of which is to be used as a repairing station by the largest ironclads and cruisers belonging to the Baltic fleet; the other is for vessels of smaller dimensions. The construction of the dock at Port Arthur as a repairing station for ships of the Russian squadron in the Pacific will also be shortly completed.

The *Kölnische Zeitung*, while pointing out that the Russian fleet is at least equal in numbers to the German, declares that the fortifying of the port of Libau places Russia in a position to inflict serious loss on her neighbour. It is free from ice all the year round, and is ten times less far from the German frontier than Kiel from the Russian, and from it the Russian squadron can reach Danzig in half the time that the German fleet can from Kiel. Happily, it will take a few years to complete it.

General.—Vice-Admiral Makarov has been giving a lecture illustrating the models of ships which, at his suggestion, were made of all such men-of-war as formed part of the Evolutionary Squadron this year. They are one-thirty-eighth the actual size, and are to be used for experiments in testing the stability of the ships in

question. Skilled workmen of the various categories have been employed in their construction so as to secure accuracy in all details, both as regards the machinery and hulls. It is hoped that they will be of great practical use as an object-lesson to those serving on board the various ships. In the course of his lecture the Admiral pointed out the tendency of modern ships when sunk to turn over. This was probably due to the weight of guns and torpedoes which they carried. He suggested that in order to preserve the stability it was necessary to allow the water free ingress to the magazines, shell-rooms, and fore-holds, *i.e.*, those parts of the ship which, in case of wreck, are always battened down. If this view was confirmed by experiments with the models prepared, then they must alter their methods of construction accordingly.

A manual of naval architecture based on lectures delivered at the Emperor Nicholas School of Naval Engineering, is to be issued, the compiler being Engineer Schlesinger. That at present in use is quite out of date, and is a translation of lectures delivered at L'École d'Application du Génie Maritime when naval architecture was quite different from what it now is.

A new series of the "Collection of Orders and Instructions of our Leading Admirals" has also recently been issued. The first dates back as far as 1860, and was compiled under the auspices of Admiral-General the Grand Duke Constantine, and is now very rare. It is "designed as a supplement to the necessarily somewhat limited regulations officially issued by Government." The work has been well received and general regret expressed that it has been so long delayed.

According to the *Russkoe Glovo*, Baron Nordenskiold is proceeding to St. Petersburg with a view to making arrangements with the Government there for the fitting out of a new North Pole expedition, the Swedish Government having already promised the well-known explorer a considerable subsidy and every material support.

The Gunnery Training Squadron under Rear-Admiral Biriled has carried out practice in the bombarding of works especially constructed for the purpose.

The Minister of Marine has decided, in order to spare the costly machinery as far as possible, to keep the Imperial yachts "Standart" and "Poliarnaia Zviezda" in the first reserve on half complements of officers and men.

During the present autumn one of the coast-defence gun-boats of the Baltic Fleet will make a trip by the Neva, various canals, and the Volga, to Astrakhan and the Caspian, and will for the future form part of the Caspian flotilla.

The Neptune Company has decided, owing to the approach of winter, to postpone the raising of the "Gangut" till next spring, but all preparations will be completed for raising the hull of the ship to a horizontal position.

The port of St. Petersburg is to be widened and deepened so as to enable ships of greater burden to come in, the Central Harbour at Kronstadt being kept exclusively for men-of-war.

The Ministry of Roads is to spend 20,000 roubles this year in choosing a site for a port in the island of Sakhalin.

The experiments made during the last naval manœuvres of the Baltic fleet in the use of Donets coal instead of English having given thoroughly satisfactory results, the Russian Ministry of Marine has decided to extend as far as possible the use of Russian coal by this fleet.—*Kronstädtski Viéstnik.*

UNITED STATES.—*The Official Report on the Wrecked Spanish War-ships.*—We have before us the full text of the official report of the naval board appointed by Admiral Sampson to investigate the condition of the wrecks of the Spanish fleet now lying on the Cuban coast. Accompanying the report are a series of photographs and a set of drawings showing the location of the shot holes on each vessel. It is not necessary to reproduce any of the photographs which accompany this report; but we present the four official diagrams showing the number, location and size of the hits on each cruiser. They are of

extreme interest, and those of our readers who have followed closely the naval events of the war will find these diagrams of special value for future reference.

In order to expedite the examination and render it as complete as possible, the board was divided into committees to consider the subjects indicated below:—

Condition of hull and practicability of saving the vessels.
Condition of ordnance equipment, magazines, etc.
Condition of machinery and boilers.
Effect of gun-fire upon the enemy's vessels.

"INFANTA MARIA TERESA."

The vessel lies nearly upright, and is down by the stern about 5 feet. She rests easily, bearing throughout the greater part of her length upon a firm coral sand bottom.

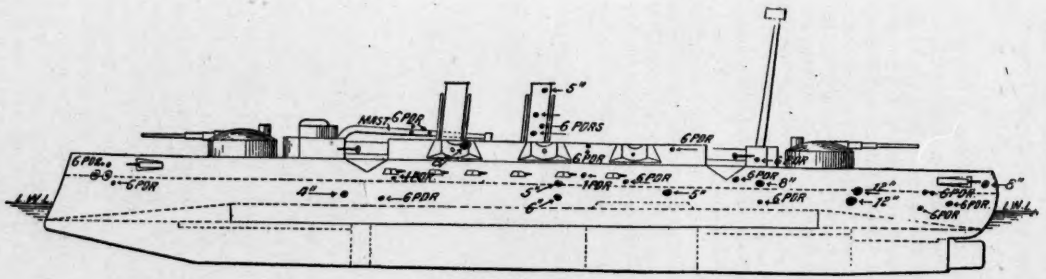
The examination of the structure extended to the protective deck. The frames above water are practically intact, and are doubtless so below water. The deck-beams above water are warped by the heat. The end bulkheads above the protective decks are badly warped by the heat of the fire; but the bulkheading below the protective deck, both longitudinal and transverse, is doubtless intact. The outside plating of the vessel is practically intact, but the heat has warped all the deck-plating above the protective deck. The board considers that, taking full account of the distribution of the weights and the strains involved, and taking full account of the reduction of strength, as pointed out, it is considered that with an intact condition of internal structure below the protective deck, the remaining structural solidity is adequate for the stresses liable to be encountered in wrecking the vessel and those liable to be encountered in any except severe conditions of navigation. There are no indications of external explosions, and all deformations can be accounted for by the heat effect of conflagration.

The 11-inch guns and mounts are in excellent condition, but eight out of the ten 5½-inch guns require new breech-blocks. The secondary battery of 6-pounders, however, is badly burned. The engines are covered with water to within 6 inches of the tops of the cylinders, but they do not appear to have been struck by exploding shells, and there is reason to believe that, if the vessel is raised soon, both the engines and boilers can easily be put in serviceable condition. As our readers are aware, the wrecking operations are being pushed in the endeavour to save this vessel.

Effect of Gun-Fire.—The "Maria Teresa" was struck twenty-nine times, as was also the "Vizcaya." More than half of the hits were by 6-pounder shells, though it was the larger shells that wrought the greatest destruction. An 8-inch shell struck the shield of the second 5½-inch gun, passed through it, ranging aft, and exploded. "The effect of the explosion," the report says, "upon almost everything about the decks in that vicinity must have been terrific." Another interesting hit, showing the effect of bursting shell in the coal bunkers, was made by a 5-inch gun, just abaft the after smoke-stack, under the berth deck. It passed through the wing passage and exploded in a coal bunker, ripping up the gun-deck in that vicinity. Another 5-inch shell did great damage in the same vicinity. Here is the description of the work of an 8-inch shell, one of the most destructive hits of the battle:—

"An 8-inch shell struck the gun deck just under the after barbette; passed through the skin of the ship and exploded, ranging aft. The damage done by this shell was very great. All the men in that locality must have been killed or badly wounded. The beams were torn and ripped, and the longitudinal bulkhead between the two cabins was badly damaged. The fragments of this shell passed across the deck and out through the starboard side at an angle of 45°. This shell also cut the fire main."

The only hits made by the largest shells landed on this vessel. It will be seen from the diagrams that no 13-inch and only two 12-inch shot-holes were found on the wrecks. The two 12-inch shells entered just under the berth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deck. They entered through almost the same hole. They exploded in the stern torpedo manipulating room, cutting the beams of the berth deck on the port side away from the frames, completely wrecking everything in that compartment, and made a large ragged hole about 4 feet square on the starboard side. They both entered at an angle of about 45° with the normal, ranging from aft forward.

"ALMIRANTE OQUENDO."

This vessel suffered more severely than any other vessel. She was hit fifty-seven times, or twice as frequently as the "Teresa" and "Vizcaya," forty-three of the hits being made by 6-pounder guns. The wreck lies uneasily, considerably down by the stern, with a slight heel to starboard. The destruction worked by our gun-fire was completed by fire and magazine explosions. The engines and boilers, however, appear to be intact, the protected deck amidships having apparently done its work well in this ship, and indeed in the case of all four cruisers; but the explosion of the magazines and torpedoes have wrecked the "Oquendo" beyond all hope of saving the ship. The hull is practically broken in two at the forward turret. An interesting structural fact is brought out at this point; namely, that there is a decided weakness at the junction of the forward and midship portions of the vessel, arising from the discontinuity of the protective deck.

The after 11-inch gun and mount are in excellent condition, and in spite of the fact that its turret was struck, the forward 11-inch gun and mount seem to be uninjured. The 5½-inch battery can be rendered serviceable by the addition of new breech-blocks. One of the after 5½-inch guns was dismounted, and another was penetrated to a depth of 1½ inches by a 6-pounder. The 6-pounder secondary battery is badly burned.

As in the case of the "Teresa," all piping and auxiliaries above the protective deck are destroyed or damaged irreparably.

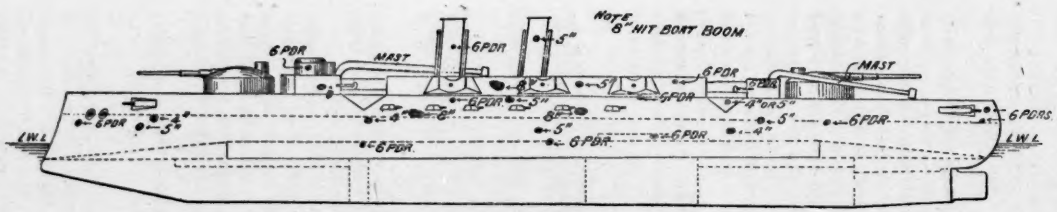
Effect of Gun-Fire.—The effects of the gun-fire upon this ship are described as being "terrific."

"The sides, smoke-stacks, ventilators, hatch-trunks, all seem to have been riddled by shells, by fragments of shell, and by an infinite number of small projectiles. When it is considered that boats which no longer exist were in place and must have been frequently hit, it will be recognised that the effect of this fire was quite sufficient to create dismay among the ship's company besides setting fire to the woodwork. The intense flames to which the three ships were subjected, and the serious explosions of magazines and torpedo-heads, caused by the heat of the flames, have so completely consumed all articles and material of inflammable nature that it has been impossible to describe more definitely and in detail the effect of the gun-fires."

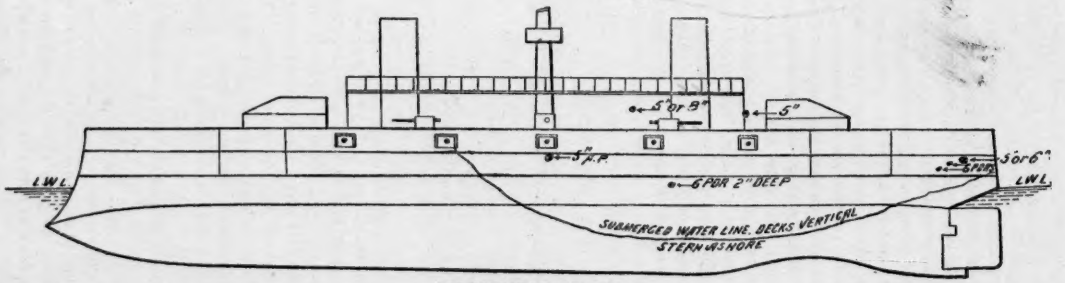
The 8-inch shells demonstrated their destructive power on this ship, one of them striking the hood of the forward 11-inch gun, at the edge of the port, bursting, and evidently killing everyone in the turret and disabling the gun. This is a case where the danger of carrying a very light shield is demonstrated. Had there been no shield, the shell would possibly not have burst. The Chinese removed these shields from their 12-inch guns to avoid a similar catastrophe.

As evidence that some of our gunners must have got the range and direction with great accuracy, we direct attention to the concentration of shot-holes below the forward 5½-inch gun sponson, where there are seven holes made by a 6-pounder besides one 8-inch hole. Another concentration of fire is seen on the berth and gun decks below the sponson of the after 5½-inch gun, where there are nine hits by 6-pounders. In calculating the effects of these little shells, it must be remembered that they all passed through the unarmoured shell of the ship and burst into flying fragments, one 6-pounder being easily capable of killing or disabling a whole gun's crew.

It will be seen from the diagram that a considerable portion of the hull above the flotation line was submerged when the examination was made, so that it is



"VIZCAYA."



"CHRISTOBAL COLON."

[*Reproduced from "Scientific American."*]

DIAGRAM SHOWING LOCATION AND SIZE OF HITS ON SPANISH CRUISERS.

probable that a dozen or more hits lay below the water and could not be observed.

The board consider that it "would be most difficult, if not impossible, to save this vessel."

"VIZCAYA."

Although the "Vizcaya" did not suffer so heavily from our gun-fire, she was so badly wrecked by fire and explosions that the board is of the opinion that it is inadvisable to attempt to save her.

So far as can be determined, the boilers and engines are intact, or, at least, not irreparably damaged.

Effect of Gun-Fire.—The "Vizcaya" received a larger proportion of large rapid-fire and 8-inch shells than any other vessel, being struck by no less than sixteen of these shells as compared with only thirteen hits by the 6-pounders. The effects on the crew were proportionately disastrous, and the report states that "it is evident that the fire of the gun crews of the 'Vizcaya' was very materially lessened and almost silenced by their not being able to serve their guns under the severe fire poured upon them by our ships."

The fact that evidence is lacking of the explosion of *many* of our shell should attract the attention of the Ordnance Department, though it is true that pieces of exploded shell may have struck parts since destroyed by fire.

The number of shell that struck the ship seemed to show by their direction that about one-half struck as she was leaving the harbour—the shell ranging aft; and the other half as she was attempting to run away.

"CHRISTOBAL COLON."

The board found the "Christobal Colon" lying on her starboard beam ends, the stern being about 150 feet from the shore, and her length lying in a direction nearly perpendicular to the line with the beach.

The depth of water at the stern is between 5 and 6 fathoms. The bow lies in a depth of about 16 fathoms.

The deck is quite vertical. The battery on the port side, with the exception of the two forward 6-inch guns, is clear of the water. The forward and second 6-inch ports are submerged. The rest of the gun ports on the port side are out of water.

The bottom valves are supposed to be open. Many of the water-tight doors were closed by the crew of the "Oregon" before the vessel capsized. The bilge keel is exposed, and also the port propeller and the propeller shaft.

There is no deformation visible in the deck or outside plating, except some dents where rocks had touched the bottom, and there is no evidence of the vessel having sustained any structural injury. The extensive side armour will prevent local injury to the sides now bearing on the bottom, and the board believed that with the integrity of the skin plating and of the decks and transverse bulkheads, the vessel can sustain herself in her present position, even in a heavy surf, without injury.

Lieutenant Hobson is now engaged in the effort to raise this ship, and should he be successful she will form a most valuable addition to our Navy. The "Christobal Colon" was by far the best cruiser in the fleet.

The total number of hits that can be counted on the "Christobal Colon" is eight or nine; but as only a small area of her sides is open to inspection, it is reasonable to suppose that she was hit more frequently than this. The most interesting hit was made by a 5-inch armour-piercing projectile, which struck the steel armour at the junction of No. 3 6-inch sponson at an angle of about 45°, and, after penetrating nearly through, rebounded. The hits on this vessel were chiefly received during the long chase by the "Brooklyn" and the "Oregon."

The conclusions drawn by the board from its examination are as follows:—

That the use of wood in the construction and equipment of war-ships should be reduced to the utmost minimum possible.

That loaded torpedoes above the water-line are a serious menace to the vessel carrying them and that they should not be so carried by vessels other than torpedo-boats.

That the value of rapid-fire batteries cannot be too highly estimated.

That all water and steam piping should be led beneath the protective deck or below the water-line and fitted with risers at such points as may be considered necessary.

Analysis of Gun-fire.

It is estimated that about 6,000 shells of all sizes were fired during the Santiago engagement, of which all but such as were aimed at the two destroyers, during the brief time that they remained afloat, were fired at the four armoured cruisers. The diagrams of the shot holes show a total of only 123 hits as having been made on the metallic structure of the vessels. At first sight this would appear to be a very low percentage for such good marksmen as our American gunners are universally considered to be. There are modifying circumstances, however, which must be considered in connection with the accompanying table analysing the gun-fire.

1. The first half of the battle, or that in which the "Teresa," "Oquendo," and "Vizcaya" were destroyed, took place under the confusion of a dense pall of smoke, none of these three or of the American vessels using smokeless powder. Moreover, what gentle breeze there was, blew off shore from the Spanish to the American fleet, bearing back both their own and the Spanish smoke upon the American gunners.

2. The smoke rendered it difficult to get the range of the Spanish vessels.

3. The diagrams show only the shot holes that were visible above water after the cruisers had settled more or less in the water.

4. There were a few hits on the starboard side that do not appear in the diagrams.

5. The woodwork having been all burned away, it is possible that the evidences of some hits have been obliterated—such, for instance, as may have been made by shells fired at considerable elevation from long range and have fallen on the decks or superstructure without penetrating the side plating.

Analysis of Hits on Spanish Cruisers.

Size of gun.	Number of hits on each vessel.				Total number of hits by each calibre of gun.	Number of guns of each calibre in action.	Number of hits per gun.
	"Teresa"	"Oquendo"	"Vizcaya"	"C. Colon"			
6-pounder	17	43	13	4	77	42	1.83
1-pounder	2	...	...	...	2	13	0·15
4-inch	1	7	4	...	12	3	4·00
5-inch	3	3	7	2	15	6	2·50
6-inch	1	1	...	1	3	7	9·43
8-inch	3	3	5	1	12	18	0·67
12-inch	2	...	...	...	2	6	0·33
13-inch	...	...	...	...	...	8	...
Totals	29	57	29	8	123	103	...

Of the 123 hits recorded, 77, or more than one-half, were made by 6-pounders. Then come the 5-inch rapid-firers of the "Brooklyn," which evidently did splendid work against all the vessels, but especially against the "Vizcaya," where seven 5-inch shells got home. The next largest number of hits is to be credited to the 8-inch and the 4-inch rapid-fire, the latter guns on the "Iowa" landing twelve shots. The 6-inch scored three hits, the 12-inch two hits, and the great 13-inch guns probably never landed at all. If they had, the mark of their 1,100-lb. shells would be plainly visible on the vessels.

In studying the accompanying table of percentage of hits per type of gun, it is remarkable how closely the results agree with the forecasts as to what would happen in a naval engagement. On the theory that there will be a large number of misses for one hit, it is readily understood how the 13-inch guns failed to score a single hit—they did not fire often enough. Moreover, of the larger-calibred guns above 4-inch, by far the highest percentage of hits per gun was made by the guns of the rapid-fire type, namely, the 5-inch rapid-firers of the "Brooklyn" and the 4-inch rapid-firers of the "Iowa." Another curious fact is that if the percentage figure (0·43) for the 6-inch slow-firers be multiplied by the respective rates of fire of the 4-inch and 5-inch guns, the results give very closely the percentage of hits recorded for these guns, namely, 4 and 2·50.

We should naturally expect, arguing along the same lines, that the 6-pounder, on account of its very great rapidity of fire, would have shown the highest percentage of hits per gun engaged; that it does not is due, probably, to the fact that some of the fighting was done at ranges which were rather long for guns of such small calibre.—*Scientific American.*

MILITARY NOTES.

PRINCIPAL APPOINTMENTS AND PROMOTIONS DURING NOVEMBER, 1898.

Captain P. A. Kenna, Lieutenant Hon. R. H. L. J. de Montmorency, and Private T. Byrne, 21st (Empress of India's) Lancers, and Captain N. M. Smyth, 2nd Dragoon Guards and Egyptian Army, have been awarded the Victoria Cross for conspicuous bravery at the battle of Khartum, on the 2nd September. Lieutenant R. H. Macdonald, R.E., has been awarded the Albert Medal of the Second Class, for gallantry in saving life in India on the 16th May, 1898. Major-General H. Le G. Geary, C.B., to be Lieut.-General. Colonels A. E. Turner, C.B., R.A.; Hon. N. G. Lyttelton, C.B; A. G. Wauchope, C.B., C.M.G.; W. Hunter, R.A., *p.a.c.*; Sir H. C. Chermside, K.C.M.G., C B., R.E.; A. Anderson, Madras Infantry; and G. Barton, C.B., to be Major-Generals. Colonel A. A. Garstin, h.p., to command the 5th and 68th Regimental Districts. Lieut.-General G. S. Young, C.B., to be Colonel of the Royal Sussex Regiment. Lieut.-General Sir F. W. Grenfell, G C.B., G.C.M.G., to be Colonel Commandant, King's Royal Rifle Corps. Colonel Sir A. Gaselee, K.C.B., A.D.C., Indian Staff Corps, to command a 2nd Class District in India, with the temporary rank of Brigadier-General. Lieut.-General Sir B. C. Russell, K.C.B., K.C.M.G., to command the Southern District. Major-General Sir W. F. Butler, K.C.B., to command the troops in South Africa, with the rank of Lieut.-General. Major-General W. J. Gascoigne, to command the troops in China and Hong-Kong. Lieut.-General Sir F. W. Grenfell, G.C.M.G., K.C.B., and Major-General Lord Kitchener, K.C.B., K C.M.G., R.E., to be G.C.B. Major-Generals W. F. Gatacre, C.B., D.S.O., A. Hunter, D.S.O., and H. M. L. Rundle, C.M.G., D.S.O., R.A., to be K.C.B. Colonel F. R. Wingate, R.A., C.B., D.S.O., A.D.C., to be K.C.M.G.

HOME.—Her Majesty the Queen has been pleased by Army Order, No. 162, to command that the 21st Lancers shall in future be designated the "21st (Empress of

India's) Lancers." The regiment has also been authorised to wear facings of French grey, the colour of the busby bag worn by the 21st when Hussars. The latter change has been made in the December Army List.

In connection with the rising on the Indian frontier occasioned by the advance of the Mad Fakir, the Government of India has ordered a field force to concentrate at Nowshera and Malakand, to operate against the fanatics. The force comprises a full division of Anglo-Indian troops. It has been placed under the supreme command of Major-General H. G. Waterfield, C.B., Indian Staff Corps. The division consists of two brigades, commanded respectively by Brigadier-Generals Hart and Reid. Colonel Abbott is in command of the line of communications.

The first brigade comprises the 2nd Bn. Royal Sussex Regiment, the Guides Infantry, the 21st Punjabies, and the 3rd Bombay Infantry. The second brigade includes the 1st Bn. of the Queen's, the 1st Bn. of the 4th Goorkhas, the 30th Punjabies, and the 37th Dogras. The divisional troops consist of the 1st Bengal Lancers and half of the 10th Bengal Lancers, the 47th Field Battery, R.A., the 1st and 5th Mountain Batteries, R.A., and two companies of sappers and miners.

The line of communications will be guarded by the 15th Bengal Lancers and the 19th Bengal Infantry.

The latest information reports that the rising has collapsed.

A special Army Order, No. 161, issued on the 18th November, announces the formation of a special service section of the Militia from the 1st December. It will consist of (*a*) individual Militiamen engaging for service abroad with the Regular forces; and (*b*) of Militiamen engaging for service abroad with their Militia units.

The General Annual Return of the British Army shows that the total effective strength of the Army on 1st January, 1898, was 221,003, compared with 191,933 twenty years ago. The most marked increase during that period is to be found in the cavalry, field and garrison artillery, Royal Engineers, infantry, colonial corps, Army Ordnance Corps, Army Service Corps, and Medical Staff Corps. The Royal Horse Artillery has decreased from 5,786 to 3,642.

There is a slight improvement in regard to desertion, but not nearly so great as might have been expected from recent legislation and the improvement in the position and pay of the soldier. 3,650 men deserted in 1897, of which number 2,344 deserted within the first 12 months. The proportion of net loss from desertion to 1,000 men is 9; 20 years ago it was 14. The percentage of net loss to recruits was in 1897 5·5; in 1878 it was 9. The behaviour of the Army is very much better than it used to be, but there are still far too many cases of insubordination. Of cases of violence and disobedience to superiors there were 1,119 in 1897; while of minor cases of insubordination there were 1,055. The Infantry of the Line head the list in regard to fines for drunkenness. Of every 1,000 men serving in the Line, nearly 100 have been fined once or more for drunkenness. The Royal Artillery are second, and the Foot Guards third. The Cavalry, Army Service Corps, Medical Staff Corps, Royal Engineers, and Army Ordnance Corps follow in order. To the great credit of the Household Cavalry, not a single fine for drunkenness was recorded in the three regiments.

There are over 74,000 men in the Army in possession of one good-conduct badge, 24,000 have two, 3,000 have three, 1,200 have four, 158 men have five badges, and 125 have as many as six badges. There are nearly 159,000 Englishmen in the Army, 16,500 Scotsmen, and 26,300 Irishmen. This gives a proportion per 1,000 of 775 English, 80 Scots, and 129 Irish. The Army Reserve, 82,005, and Militia Reserve, 31,049, are both over the establishment, but the Militia, Yeomanry, and Volunteers together are just on 50,000 below strength.

Captain G. H. W. Nicholson, R.A., until lately a subaltern in the battery, delivered a lecture recently at Woolwich on "The part played by the 32nd Field Battery R.A., in the Khartoum Expedition, 1898." He pointed out that Major W. H. Williams, who commanded the battery, in January of this year, was called on for suggestions for taking his battery into the Sudan, and was told that the English and waler horses could not be taken. He suggested mules, and eventually this experiment was tried. That form of draught having been settled on, suitable harness had to be invented. Each gun was to be drawn by eight mules, the drivers riding the near ones and gunners the off ones. In order to get increased pace, three extra mules were added to each team, making eleven in all. By July, 170 mules had been trained by the battery. With regard to the mules, they were transformed, by care, from the brutes they are considered to be, into tractable and willing creatures. So successful did they prove in the task they were asked to perform, that it was believed the Sirdar was about to equip two similar batteries in the Egyptian Army. A great difficulty to be overcome was the question of common shell. They could not be supplied from home, and so they were made in the Egyptian Army workshops, placed at the disposal of Major Williams by Lieut.-Colonel W. S. Gordon, R.E., attached to the Egyptian Army. No wagons were to be taken, and two Maltese carts were chosen, the object being that these carts should be galloped backwards and forwards from the battery to the river for ammunition, for carrying which special boxes were made. Two of these formed a mule-load, and each box contained five shrapnel, five cartridges, one box of fuzes, and one of tubes. The battery consisted of the following numbers: Officers, 5; non-commissioned officers and men, 135; Arab horses, 25; mules, 77; guns and limbers, 6; Maltese carts, 2. The animals marched from Atbara to Omdurman, meeting the guns at Wad Hamed. Captain Nicholson then minutely described the battle, with reference to the positions, ranges, targets, etc., of the battery, and the final march into Omdurman with Maxwell's Sudanese Brigade, the battery being the first British troops to enter the town. Finally the effect of the fire was gone into.

The following interesting letters regarding the battle of Khartum, and the subsequent visit of the Sirdar to Fashoda, were written by an officer of the Royal Artillery, attached to the Egyptian Army.

Khor Shambat,
Omdurman,
September 5th, 1898.

On Friday, August 26th, in the afternoon, the artillery left Wad Hamid and got to the other side of the Shabluka Cataract about 9 o'clock on the following day; next day we marched to a place called El Aberdah with the whole army; we halted there for one day, which day I spent on patrol with my two Maxims and the cavalry. On Tuesday, August 30th, the whole army marched away, soaked to the skin, there being heavy rain during the night; we did about 13 miles that day and again 10 miles the next day. On September 1st we again left at 6 a.m. soaked to the skin, having had a pouring wet night and morning. We marched that day until about 12 o'clock, when we prepared to encamp in and around a small village about 7 miles from Omdurman. News came in about 12.30 that about 30,000 of the enemy were within 3 miles of us coming on to the attack; we at once had a bit of lunch and then formed up ready for the enemy to come on; however, that night they retired a short distance and encamped in the desert for the night; we retired again on to the village and formed an entrenchment all round the village with its ends resting on the river and at each end of it a gun-boat was stationed. I was on the extreme right of our position. During the night we had one alarm as they came on to a hill about 1,500 yards from our centre and began to fire at us, but did no harm. At 6 o'clock in the morning, as it was believed the enemy had retired in towards Omdurman along the desert, we all

loaded up our baggage and formed up to move off; we had no sooner done this than news came in that the enemy were advancing to attack us; we at once went into our entrenchment and we waited the attack. At 6.30 the enemy appeared in sight, and looked an enormous army. I honestly believe there were 35,000 men; at 6.40 on my side they came to within 3,000 yards, and I at once opened fire on them; they did not like it, but contined working round to our right. Afterwards they got round to our right, but never would face the artillery fire, and finally went back to about 2½ miles off the centre of our position and massed there in rear of and to the left of a small hill. I made some very nice shooting into them whenever they exposed themselves, which was fairly often. After they had got out of range we did nothing for about half an hour. In the meantime on our left the British Brigades had driven back a determined charge, and the 21st Lancers went out and made their charge. After waiting half-an-hour I was ordered with my battery to join Colonel Macdonald's 1st Brigade on the right flank.

We had not advanced 500 yards when we saw dense masses of the enemy on our front and right flank, and were under their fire. We all three batteries came into action and were at once charged by a large body of horsemen and infantry. Their pluck and fanaticism it is impossible to describe; one knew that it was a case of their killing us or we them, there was no retreat about a single one of them; the last man died about 100 yards in front of my guns. We had no sooner driven them off, than I was ordered by Colonel Macdonald to go up to the front flank and repel an attack there. Immediately on my arrival there I saw masses of the Dervishes with their flags forming up to attack us; almost at once my battery was charged by about 150 cavalry supported by a mass of infantry; I had two Maxims on my right and infantry on my left, the 9th Soudanese, and this lot were fairly well killed off. You must remember that had not the infantry and artillery been absolutely steady and in hand these Dervishes would have broken the line, and then it is impossible to say what would have been the consequence. We were in this place charged by four different masses of Dervishes, but the last two charges were not so fanatical as the first, and when the last had stopped 500 yards from us the battle was ended. I cannot speak too highly of my Egyptian artillerymen, as I always do. I fired 900 shell during the day, or rather morning, as I do not think I fired a shell after 11 o'clock. I had a horse killed and a mule, and two mules wounded. One officer wounded, one man killed and nine wounded.

At 1 o'clock we moved towards Omdurman, and having watered our animals and men, at 5 o'clock entered Omdurman. While we had been fighting on the right, the Sirdar, with four battalions and three batteries had pushed on towards Omdurman, and at 5 o'clock he got in with only very slight street fighting, and only just missed capturing the Khalifa, who had left the field of battle when he saw that it was all up. We marched right through Omdurman and bivouacked at 9 o'clock in the desert on the other side, and the next morning came back and encamped here. I am happy to say that I was lucky enough to have been in the fight with Macdonald's Brigade, as it was far the best thing in the whole day.

On Sunday we had a great ceremony on the other bank, when we were all delighted to see the Union Jack hoisted alongside the Egyptian flag. This morning I had a look round the Khalifa's house and the Mahdi's tomb and took some photos. I have a lot of stuff of sorts that I got. I have just seen my officer who was wounded; he was shot next to me and the bone of his leg is broken to pieces, and I am afraid he will lose it; I am awfully sorry, as he was a fine young chap. We are of course all delighted at being here and having smashed up the Khalifa. There is no doubt that when they advanced to attack they thought that they were going to defeat us, and there is no question that they showed the most extraordinary courage and fanaticism.

A.S.W. "Dal," White Nile,
en route to Fashoda,
September 14th.

On the 10th September I embarked all the guns and 70 men of my battery on board a boat, and I myself came on board this steamer, which is towing up my boat; our flotilla consists of 3 gun-boats towing up two battalions of Soudanese and one company of Cameron Highlanders. This is the Sirdar's own vessel, and on board we are a party of six, namely, the Sirdar, Colonel Wingate, and the three A.D.C.'s, Captain Watson, Lord E. Cecil, and young Roberts (Lord Roberts' son). We have now been four-and-a-half days steaming up the Nile. Our object is to occupy a place called Fashoda, about 500 miles from Khartoum; intelligence has arrived that this place has been occupied by some European, and we believe it to be Marchand, the French explorer. The situation at present is as follows, and is very peculiar. The Dervishes before we advanced had sent up two steamers to go to Fashoda. These steamers were fired on at Fashoda by the European, whoever he may be, and the two steamers then went down stream again, and one steamer was sent to Khartoum to get reinforcements from the Khalifa. When the steamer arrived the rule of the Khalifa was at an end and it fell into our hands; from them we first heard of the Europeans at Fashoda. The Dervishes at Fashoda do not know that the Khalifa is finished, and are daily expecting reinforcements. Before this letter is finished I hope to be able to give you a satisfactory ending to it. We have now entirely left the sand and desert and dry Egyptian climate, and have got into damp tropical climate with dense vegetation on each side, which appears to be full of game. I don't have much time to shoot, as we steam all day and tie up at dusk, and collect wood for the steamers, and then go on at daylight. We have just been watching six or seven hippopotami quite close to the steamer, but did not shoot at them. I got a very fine bustard the night before last. It is very interesting being with the Sirdar and Wingate, as you hear all the latest information from villages where we stop. I am afraid the Khalifa has slipped us for the present We are in the real rainy region now; last night we had the most torrential rain, and the result is, this morning though damp is cool. I am afraid this is a very feverish place. I am very lucky to have been chosen for this trip, as it will be quite historical if the European turns out to be Marchand, who started from the West Coast some two years ago I believe.

16th September.—Since I last wrote we have surprised and captured a small Dervish post and their biggest steamer the "Safieh." We knew that this steamer was there, as I have told you previously. About 6.30 yesterday morning we sighted their encampment and the steamer alongside. At once the gun-boat "Sultan," which was unencumbered with troop-boats, steamed ahead. The fools of Dervishes did not chuck up at once, but commenced firing; the result was that after half-an-hour's firing from the guns and Maxims all the Dervishes were killed, wounded, or had run away, and with very bad luck the "Safieh" had a large shell hole through her boiler. This "Safieh" is a very historical vessel. She was one of Gordon's boats, and was that on which Lord Charles Beresford was when they went up to Khartoum in 1885. After all was quiet we went in and took possession of everything. We lay about 500 yards off the "Sultan" out of range, and it was a very pretty sight seeing her shelling the place. The Dervishes only just missed the "Sultan" with their only gun, once or twice. We captured a lot of sheep and goats and also thirteen large Nile boats. The "Safieh" will be towed down to the Atbara camp and will have a new boiler put in her and be all right. We are still in the middle of dense tropical jungle, and the dew at night tied up to the bank is awful; everything is soaked through; the mosquitoes and other flies are innumerable; everybody is covered with bites. The river here simply swarms with hippopotami. During the day you only see their great heads coming up above the water, but you can see any amount of

those. We have now done about 380 miles up the river, and have another 120 to do before we get to Fashoda.

18th September.—We are now within three hours' steam of Fashoda, and are waiting while the steamers fill up with wood. The Sirdar now thinks that the French will not clear out; we have not yet had any answer from them. If they do not clear the Sirdar is going straight south of them, and going to make a station at the mouth of the Sobat River, and another just south of Fashoda, and await instructions from the Government; in this event, I and my battery will most likely be left there for a time at least, so that you must not be surprised if this letter ends rather abruptly. A gun-boat is being sent on to ask them who they are, and by what right they are on the Nile, and the Sirdar awaits in this boat for their reply. I think we have got hold of both big tribes of Soudanese, but am not quite certain yet. Plenty of rain down these parts, and the mosquitoes ferocious. We are now about 430 miles south of Khartoum, and 2,100 miles south of Cairo; it is a good long way when one thinks that Brindisi from London is only 1,400 miles. I shall probably conclude in my next.

19th September.—We have had a most interesting morning. At 7.30 this morning we saw a boat coming towards us flying the French flag (I took a photo; hope it will turn out well). We took them in tow, and received a letter from Marchand, the Frenchman who was in possession of the place. He informed the Sirdar that, under orders from his Government, he had occupied the place and about 600 miles of Nile. The gun-boats, "Sultan" and "Abu Klea," went on, and two officers landed and informed Commander Marchand that the Sirdar would like to see him. We then had got up to the shore, and received Captain Marchand and another officer on board this boat with due honours (I took a photo when he was near the boat). The Sirdar and Marchand then had a long talk, in which the pith was that the Sirdar said that he had the preponderating force, and that the French had no right to be there; Marchand said that he was there under orders from his Government, and that should the Sirdar use force, he could only with his force die at his post. The Sirdar said that he had no wish to do this, but that he would allow them to stay there pending orders from their Government, and should leave 600 men and a commandant of the district, and hoist his flag. Marchand said, "All right." We at once landed a little to the south of the French and the flag was hoisted. I fired a salute of twenty-one guns, and there was a general salute by the 11th and 13th Battalions, and 100 men of the Cameron Highlanders, who are with us. I left four guns at this place, and the 11th Battalion was left as well. We are now steaming south to the Sobat River, where we are going to establish two posts on each side of the river. I shall have my battery split up in three places, so am going to live on the gun-boat "Abu Klea," which will ply on the 60 miles between Fashoda and the River Sobat.

20th September.—I have just received orders that we are to go up the Bahr-el-Ghazal and the Bahr-el-Jebel to hoist the Egyptian flag, as soon as the Sirdar has gone down.

Gun-boat "Abu Klea,"
Bahr-el-Ghazal,
September 29th.

I think my last letter ended with my arrival at the River Sobat with the Sirdar. Immediately on my arrival there I shifted my kit to this gun-boat and went straight back 60 miles to Fashoda, where I filled up with provisions. With me I have Lieutenant E. O. A Newcombe, R.E., Major H. E. H. Smith, Army Medical Corps, and Captain Stanton, Oxfordshire L.I., all attached to the Egyptian Army. The instructions from the Sirdar were that I was to go to various places on the Nile and hoist the Egyptian flag there, so I decided to go to a place called Nosma or Reh on the Bahr-el-Ghazal, about 210 miles south-west of the Sobat. After getting a month's stores on board I left Fashoda again on September 22nd and got to Sobat on September 23rd, and left the same day. I

have now been away exactly a week and am on my way back, having planted the Egyptian flag at Nosma or Reh, and also here about 30 miles from it. I put one down here as I think the French are likely to see it. We have had a most interesting trip. I will not go into a long description of the country, but the only descriptions of it are in Dr. Junker's "Central Africa" and Gessi's "Seven Years in the Soudan." At this time of the year the rains are just finishing, and in consequence there is a lot of water about. I have been through, since we left Fashoda, about 200 miles of vast marsh, with just a narrow channel through it. This channel is continually getting choked with what is called "sudd," and at times becomes impassable. If you get stuck in this stuff it is a bad look out for you. Being the only steamer I have had to be very careful, and I have been lucky as I only had to clear out about 50 yards of stuff, and hope I shall be as lucky going back. The weather is quite nice, as nearly every night we have rain, which keeps it cool. The awful part of the voyage has been the mosquitoes. They are far away the most numerous and most vicious I have ever seen. In the Soudan (this is called Equatoria) where it is so dry there are no mosquitoes, and so not knowing I was in for this trip I left my mosquito curtains at Berber. Without curtains sleep is impossible. I slept properly for the first time for seven days last night, as I think at last I have defeated the little beasts. On my head I wore a wideawake felt hat; over that, tied tightly round my neck, I wore a veil, with a silk handkerchief round my chin and neck; pajama coat and ordinary coat tightly buttoned up; on my hands leather gauntlets with my wrists wrapped in handkerchiefs; three pairs of socks; trousers with pajamas with feet to them over the lot. With this lot on I managed to sleep, though perspiring is not the name for it. I was a good deal bitten about the neck, hands, and chest, as they managed to creep in. I shall never forget the Bahr-el-Ghazal mosquitoes; they bite easily through two pairs of socks. It is a wonderful country for game. I have shot two hippopotami, one on land and one in the water; they simply swarm. I shot them with the ·303 rifle and a hard bullet. The one I shot in the water I got first shot below the eye, and he came near the steamer, and while he was rolling over and over in his dying struggle I got him again in the head, when he sank like a stone, as they always do; I hope to find him floating on my way back, though I am afraid he will be a bit high; the other one two of us got on land, shooting him through the lungs and liver; he was an enormous great brute; we had some hippopotamus steaks, and they were very good. We have also seen some grand tusker-elephants but have not managed to bag any. We counted in the distance one lot of harte-beast 130 in number. I have not seen any giraffe yet, but hope to. We had no reliable guide with us, and in consequence it has been a little trying, as there are numberless channels which lead to nowhere, being blocked with "sudd"; this "sudd" is peculiar stuff, as it does not reach to the bottom of the river, but is practically a floating island. The men are now busy cutting wood for the steamer, and I hope to leave here in half an hour and get to Sobat to-morrow morning, steaming all day and night; it is about 170 miles from here. I am then going up to explore the Bahr-el-Jebel and the Bahr-el-Zeraffe; these are the two branches of the Nile which lead to the Victoria and Nyanza, but we hear they are both blocked with "sudd." I am very lucky to have had this job given me by the Sirdar, as it is most interesting; when I am to get home, goodness knows.

1st October.—I am now on my way back to Fashoda from Sobat, where I arrived last night. We had a pleasant trip, killing a hippo on the way; we had great excitement over this one, as we shot him from the steamer, and I went on shore to finish him off; a soldier was just coming on shore to help cut him up, when suddenly another hippo made a rush at him and caught him by the leg and mauled him very badly; it put the funk into the other men, and I had great difficulty in getting them to cut off the head. I am now off to see the man commanding the district at Fashoda, and to get his orders what to do next, but I expect I shall

have another trip, up the river at once as the French say they have a steamer up there, and we want to locate it. I have now been up the river 700 miles from Khartoum; it is a long way. Yesterday we saw on the bank of the river thirteen elephants, they did not seem to mind us at all.

Well, I have had an eventful September; I have never had a month like it, and doubt whether I shall ever have another—I have hardly had a day without some excitement.

Still heavy rain every other day.

3rd October.—En route from Fashoda to River Sobat.—I got down to Fashoda about 4 o'clock on the night of the 1st October. I there interviewed the Governor of the district, Major H. W. Jackson, and made up my future plans. On the morning of the 2nd October (yesterday) I left at daybreak and went 25 miles down the river, and then sent off a man to try and get some Dervishes, who were believed to be about 30 in number, to come in and lay down their arms; I had to wait about five hours and then about 300 Diaka Soudanese came in under two Shiekhs to give their allegiance to Government, and immediately after the Dervishes came in, to my delight, to the number of 170 with 75 rifles. I stuffed them all on to a barge I had with me, and took them all back to Fashoda, where I arrived at 9 o'clock last night, and handed them over to the Governor; it was a very successful trip and has cleared out the other bank of these marauding Dervishes. I left Fashoda this morning at 9 o'clock, and am now on my way to Sobat, and thence am going to explore the Bahr-el-Jebel and the Bahr-el-Zeraffe, the two branches of the Nile which lead down to Uganda and the great lakes; these branches are said to be blocked with "sudd," the vegetable obstruction I have spoken of before, so I am going to see if it is the case; the first 80 miles is the same part I went up last week, and then we branch off to the south. Still heavy storms; I shall be very thankful when they stop; however, lovely day now with a pleasant breeze. I expect to arrive at Sobat, 60 miles off, at 6 o'clock this evening.

7th October.—Bahr-el-Ghazal.—I am now on my way back to Sobat; I have been 80 miles up a river called the Bahr-el-Zeraffe, and then came on another 50 miles, and we tried to get up the Bahr-el-Jebel, but were blocked by "sudd" after the first 300 yards. I could have got on up the Zeraffe river, but as we expect the post-boat in from Khartoum I don't want to miss meeting it. I hope to go up the Zeraffe after the post-boat is in. We have just finished prospecting a side channel which we thought might lead somewhere, but found ourselves blocked after about 6 miles. We hope to be in Sobat to-night about 7 o'clock, as we have about 80 miles to go back. This trip we have seen giraffe for the first time; most extraordinary they look at a distance. The weather is improving; we have had no rain for four days, and I hope are now coming to the end of it. During the last twenty-eight days I have travelled on this old river 1,000 miles. I am very anxious to hear some news from the world.

AUSTRIA-HUNGARY.—*Course of Instruction for Senior Officers of the Landwehr.*—It is generally known that in the Austrian Army all captains must pass the regulation examination before promotion to major. In order to afford officers of the different branches of the Army an opportunity for preparing themselves for this examination a course for senior officers (*Stabsoffiziers-Curs*) was started in Vienna in 1892, which however was suppressed in 1894.

The *Armeeblatt* lately announced that the analogous course, which exists for officers of the Landwehr, will extend in the future over a period of seven months instead of five. For exceptional reasons this course began this year on the 20th November, and will terminate on the 20th June, 1899. For the future the normal course will last from the 21st October to the 20th May The programme of subjects taught has not been changed, but a longer time can now be allotted to practical work, than could be done formerly when the course only lasted five months. The number of officers attending the course is limited to 40 captains

(infantry and cavalry). The course of instruction includes :—Tactics, a knowledge of country, military geography (the theatre of an Austro-Russian war, the Balkan Peninsula, and the Austro-Italian frontier), arms and equipment, military organisation, fortification, fortress-warfare, pioneer service, military law, hippology and equitation. The instruction is as far as possible made practical. The object of the course is not only to complete the knowledge indispensable for Landwehr officers recommended for promotion, but to make certain that they possess the knowledge and also to teach them the methods they should employ for imparting professional instruction to their subalterns. The most important subject, viz., tactics in all its branches, is entrusted to three professors, who have each a group of students to instruct. A professor is in charge of each of the other subjects taught.

The teaching staff includes :—Two lieut.-colonels, a colonel-auditor (*Oberst-Auditor*), a major and three captains, one of whom is a cavalry officer.

As pointed out above, great stress is laid on the practical instruction ; the programme for the period devoted to it consists of :—Practical exercises on different grounds ; visits to battle-fields ; firing exercises and experiments ; pontoon drill, during which a bridge is thrown across some river ; and, finally, an instruction journey of three weeks' duration is made through country important from a military point of view, during which the students have to study the influence of ground on strategy and on battle-tactics ; visits being also paid to certain fortresses and naval arsenals. The above shows the importance which is attached in Austria to a sound training for the senior officers of the Landwehr.

COREA.—The following extracts from the reports drawn up by Lieutenants Afonasiev and Grudzinsky, of the Russian Army, on the training, by them, of Corean troops in 1896-98, have been communicated by an officer, and will be found of interest.

There were five Corean battalions in Seoul, numbering 3,325 men ; and 85 cavalry were also quartered there. In the school opened in August, 1896, there were thirty-three pupils drawn from the classes most loyal to the King. Seven Corean officers assisted in the interior economy of that establishment, under the orders of the Russian Lieutenant Khmyelev.

The first party of Russian instructors, comprising two subalterns, a doctor, and ten non-commissioned officers, reached Seoul in October, 1896, and were to take their orders from Colonel Putyata, the Russian military *attaché*. The Corean Ministry of War begged that the instruction of all the available troops, some 2,200 in number, should be forthwith commenced. The Russian Minister, however, replied that he must first receive orders on the subject from St. Petersburg. Meanwhile a programme was drawn up, by which 800 men were to be formed into an independent battalion and drilled on the Russian system. Instructions having been received from Russia, this plan was put forward. But the Coreans at first declined it, asking for 2,200 to be immediately taken in hand, alleging that, if a beginning should be made with the smaller number, the others would be discontented, and perhaps raise a rebellion. Eventually, however, the Russians had their way, eighty Corean soldiers being allotted to each Russian non-commissioned officer, not one of whom knew a word of the language of the country. It was impracticable to collect all the 800 men together at first, therefore it was decided to drill them in separate detachments, corresponding to the battalions from which they were drawn. The Corean Minister of War thought once a day would suffice for each individual's instruction, but Colonel Putyata, thinking otherwise, had the men taught twice daily. On the second day of the course, however, one company commander went on leave, a second said he was ill, a third had to bury his mother. It was a long time before the Coreans could be brought to understand that no one could absent himself without the permission of a Russian non-commissioned officer. During the first week, all the time was

taken up by the instructors making themselves acquainted with their pupils, in drawing up nominal rolls in Russian, in teaching the men how to wear a belt, and how to put on their trousers, etc. All this was difficult, since the sole interpreter was a Corean officer who knew only very little Russian. However, by means of signs and mimicry, matters began to progress. The officers were, at first, drilled together with the men. At the end of the first week, the Russian non-commissioned officers had all lost their voices, but had succeeded in introducing some order in the ranks. Their pupils used to blow themselves out when their belts were tightened—a proceeding which they disliked.

The Corean soldier is physically weak; after standing at attention for about ten minutes he gets tired and, on being told to stand easy, nearly all sit down on their heels and so repose. During the second week an interpreter arrived, as did also a Corean cadet able to speak Russian. The Corean officers were much easier to instruct than their men. But the latter were fairly apt in learning to take their rifles to pieces, in putting them together again and in cleaning their arms.

Colonel Putyata inspected the battalion at the end of a fortnight and was much struck by the progress made. The marching was certainly original but can be improved; the double, however, was so good that nothing better could be expected. The rifle was rather too heavy for the soldiers, so that they had to stand at ease every five minutes. The aiming drill was indifferently learned, partly because the hands were weak and partly because the eye was not accustomed to sighting. After about six weeks' training, the men were ordered to prepare for guard duty at the Palace. The gymnastic training was not a success, the Coreans being afraid of falling, especially from the trapeze. In two months' time the experiment of guard mounting was made but had to be abandoned, after about three weeks had elapsed, owing to the bad state of the guard rooms, which the Corean War Ministry had refused to have repaired. The action of the Russians then had the desired effect and guards were again mounted.

After the instructional battalion had been in existence for four months, musketry practice was commenced with ball ammunition. The men were at first much frightened, but the feeling of alarm soon began to pass away. This course of musketry lasted for two months, and although the results of the target practice were not great, yet, considering that the men had never previously fired, they may be considered satisfactory. Meanwhile the company instruction had been going on very well, and the military pupils had been granted commissioned rank.

A second party of Russian instructors reached Seoul in July, 1897, to raise a second battalion. But by this time the five battalions from which the selections were to be made did not number in all more than 600 men, so that it was impossible to raise from them the 1,000 which it had been intended to train. The Russians were much amused at the shifting of Coreans from one barracks to another, in order to make it appear that each had its complement. Not for two months could anything be done, owing to the obstructiveness displayed by the Corean War Office. Even then, in September, the Corean officers were unable to assemble their men; there were no battalion commanders to be found and the War Office made no sign, notwithstanding the agreement previously arrived at. Finally, however, the battalions were mustered and found to be very much under their proper strength, in consequence of the peculation which existed for the benefit of the authorities. It was possible, nevertheless, to select 571 men, who were formed into three companies, to each of which two Russian non-commissioned officers were allotted as instructors. The Coreans did all they could to avoid being chosen by feigning illness, and in other ways. Some of the selected ones were of non-commissioned rank, and it was remarked that they were, in every respect, considerably inferior to the privates. This fact, the Coreans explained, was due to the venality of the officials in the Ministry of War, every soldier having to pay as much as 12 dollars on joining, whereas

non-commissioned officers have to pay more, as their duties are extremely light; hence old men having saved more than younger ones, are better able to pay for the privilege of obtaining their posts. The officers also pay for their rank. The system of instruction pursued in the newly-raised battalion was identical with that already applied to the first one, nor did the results obtained differ to any extent.

Originally the demeanour of the Corean officers towards the Russian non-commissioned officers had been cold. The former did not like having to stand on one leg, and it had to be explained to them that the difference between the Corean officers and the Russian non-commissioned officers was very great, as the latter were educated men, whereas the former had never learned anything. The Russians were, therefore, ordered to adopt, towards the Corean officers, the tone of a commanding officer, which resulted in improved relations between them.

The raising of the second battalion was a further heavy blow to the pockets of the Corean Minister of War and of the officials surrounding him.—*Translated from the Russian.*

GERMANY.—*Competitive Trial between War-dogs.*—Last June there took place at Oels (Prussian Silesia) a prize competition between war-dogs on the occasion of a dog show organised by a society of civilian Chasseurs. The Kaiser, to show the interest which he takes in this branch of military organisation, took on himself to defray all the expenses connected with the competition, and had a special report of the results forwarded to him. The competition took place in very favourable weather. Colonel von Arnim, the inspector of Chasseurs, being present. The jury was composed of officers from different Chasseur battalions. The trials included the behaviour in leash, the carrying of dispatches over a distance of from 3 to 5 kilometres, with obstacles for old dogs, and free from them for young ones; then the return to the place from which they started, the finding of their masters, their behaviour as watch-dogs, and finally the hunting out of wounded men and giving voice as an indication of the success of their search.

The ground chosen presented designedly some great difficulties. In carrying their dispatches the dogs had to cross some marshy valleys, fields covered with damp, high weeds, and some populous villages, where music and dancing were going on, without being distracted from their mission. They ran on the average at the rate of 1 kilometre in three minutes and a half.

Out of 23 dogs taking part in the competition, five received prizes. The first prize was awarded to a dog belonging to the 4th Company of the 5th Battalion of Chasseurs, a shepherd's dog with a yellow coat and excellent in every respect. The four other prize dogs, and a few which received "honourable mention," all belonged to other battalions of Chasseurs.

The first prize, which was awarded to the soldier in charge of the dog, was a rifle and 60 marks, presented by the "Inspection" of the Chasseurs. The Civil Society also gave 200 marks to be divided among the five prize winners.

Next year the competition will take place at Hirschberg.

Army Shoemaking.—Some interesting experiments were lately carried out in bootmaking at Berlin. Twelve hundred shoemakers, drawn from each of the 18 corps d'armée, with the exception of the two Bavarian corps, were ordered to Berlin. A certain number of officers and under-officers were also summoned to supervise this drill of the shoemakers, as well as 40 locksmiths, who were to be in readiness in case of necessity to repair any damages to the machines. Two of these were worked day and night; the one from 2 a.m. to 2 p.m., the other from 2 p.m. to 2 a.m. The 12,000 shoemakers were able to complete each day 2,500 pairs of boots for cavalry and infantry. For the ten days during which the work was carried on the men were paid at the rate of 6s. 5d. per diem.

Sugar as a Ration.—Some trials were made during last year's autumn manœuvres of the value of sugar as nourishment for troops. In each of the companies directed to carry out experiments, ten men, chosen from among the least vigorous, were told off as the subjects for experiment, another ten being also selected, who were strictly confined to the service rations. At first the men were supplied daily with seven pieces of sugar, which was increased gradually to 10 or 12. The results were found to be as follows :—

During the manœuvres the weight of the men to whom sugar was supplied increased proportionately more than that of those who were without it; while the men themselves were in better health and more vigorous than they had been before.

When on the march a piece of sugar relieved hunger and appeased thirst; while thanks to it, it was found easier to fight the exhaustion, etc., produced by the heat.

No objection was made by the men to taking the sugar.

The results of the experiments were considered successful, and Doctor Leitenstörfer, under whose superintendence they were carried out, has suggested that sugar should be added to the rations, in one of the three following ways :—

1. As a supplementary allowance, with the view of improving the men's daily ration.
2. As an integrant part of the men's reserve store of provisions and of the supplies for fortresses, hospitals, and ships.
3. As a temporary allowance, for strengthening the men and renewing their vigour on the march.

Bicycle Riding.—A detachment of bicyclists of the 2nd Infantry Brigade of the Guard Corps lately made a six days' trip for exercise. The object of the trip was not alone riding, but reports were to be sent in as to the state of the roads, on the water-courses, their fords, their practicability for different troops, and the nature of the ground.

The detachment consisted of 28 men and six officers; the latter were mounted on tandems and the men on bicycles. The first day Frankfort-on-Oder was reached, a distance of 85 kilometres, a halt of four hours being made at Müncheberg. The second day, passing through Küstrin, the detachment arrived at Königsberg, the distance covered being about 75 kilometres. The third day the party divided and proceeded to Angermünde by different routes, covering from 35 to 40 kilometres. The Oder was crossed at Schwedt; some of the party using the bridge, while the remainder crossed on a raft, which they constructed themselves. The fourth day Templin was reached, a distance of 35 kilometres, and on the 5th day Oranienburg, the distance covered being 45 kilometres; Berlin being reached the next day after a ride of 30 kilometres.—*Revue Militaire de l'Étranger.*

The Re-organisation of the Field Artillery.—The *Kölnische Zeitung* states the Government are going to demand the necessary credits to enable them to give a brigade of field artillery to each infantry division. Each corps d'armée (normal strength two divisions) will then have at its disposal two brigades of field artillery of two regiments each; although among the latter will be a certain number of batteries less trained than those of the artillery regiments already existing. Each corps d'armée will equally dispose of a group (*Abtheilung*) of howitzer batteries. Finally, the groups of horse batteries will be reduced strictly to the number necessary for the independent cavalry divisions in case of war. The question will also arise of grouping the squadrons of mounted estafettes, so that the instruction given to these special corps may be more uniform.

A New Decoration.—The Red Cross Medal (*Die Rothe Kreus-Medaille*) has been created by the Emperor, at the suggestion of the Empress. The medal will have three classes and be given to persons belonging to the Red Cross Associa-

tion, who distinguish themselves particularly by their zeal. The medals of the second and third classes will be of silver and bronze respectively, bearing on the one face the Red Cross, with the letters W. R. (Wilhelm Rex) on top, and at bottom the letters A. V. (Augusta Victoria). On the other face is the inscription "Für Verdienste um das Rothe Kreuz" (for services rendered to the Red Cross), surrounded by a wreath of oak leaves. On the medal of the second class the cross is of red enamel. The insignia of the first class consists of a cross in red enamel with a siver edge, and gold crowns at the four extremities. The medals of the second and third classes are suspended from a red, black and white ribbon, while the cross of the first class is worn on the left breast as an order.

It is intended to confer this decoration, not only on men, but also women and girls, who have successfully worked for some years in the interests of the Red Cross, or who have distinguished themselves by remarkable personal acts of devotion in any rank of life.

The Non-Commissioned Officers' School at Marienberg.—On the occasion lately of the twenty-fifth anniversary of the creation of this establishment, which includes both a school for non-commissioned officers and a preparatory school, the *Allgemeine Militär-Zeitung* publishes an article giving some particulars about its origin and actual organisation. It may be remembered that after the war of 1870-71, the German army of occupation in France was maintained at the expense of that country. It is probable that the requirements of that army were very large, because the allowances realised on the funds paid to Germany by the French Government amounted to no less a sum than 26,763,900 marks. Of this sum the 12th Saxon Army Corps received as its share 1,207,000 marks, 593,700 of which were devoted to founding this non-commissioned officers' school at Marienberg.

The number of pupils is 400, they remain two years in the preparatory and two in the upper school. When they leave, the pupils enter the Army either as simple soldiers or as lance-corporals; those who come up to a certain standard at their first examination receive the grade of non-commissioned officer. They are obliged to serve at least four years with the colours after leaving the school. As the pupils do not take the oath of fidelity, they are not punished so severely as ordinary soldiers when they commit breaches of discipline; but in all other respects their mode of life is similar to that of the soldier, as they are fed, clothed, and housed similarly to the men of the Active Army. The practical instruction includes drill, bayonet fencing, gymnastics, and firing at a target. The theoretical course includes religious instruction, integral calculus, the German language, geography, history, drawing, military modes of expression, stenography, French, and singing. In addition to the officers and non-commissioned officers attached to the school there are a certain number of civil professors. The *Allgemeine Militär-Zeitung* thus concludes its article:—"The results obtained by the school have been very satisfactory, as was shown at the great Imperial Manœuvres in 1882 in the neighbourhood of Riesa. This was the first time on which the pupils of the school had appeared before the supreme head of the German Army, and they attracted particular attention, both at the review and during the manœuvres by their good demeanour, their endurance, and their enthusiasm."

The Non-Commissioned Officers' School at Neu Brisach.—This school is probably to be transferred to another town in Germany. It was founded ten years ago at Neu Brisach in the hope that the majority of the pupils would be Alsatians desirous of a career as non-commissioned officers in the Army. This hope has not been realised; out of 2,166 pupils who have passed through the school since it was founded, only 256 have been Alsatians. The school is therefore to be transferred, and its place at Neu Brisach will be taken by some foot artillery.—*Allgemeine Militär-Zeitung.*

Electric-Light Wagons for the Army.—The military authorities have been making experiments with one of these wagons, which have been very satisfactory.

It consists of a body on four wheels, similar to the transport wagons now in use in the Army. It is intended to light the battle-field by electricity, which will be of great assistance in searching for the wounded. The dynamo will be worked by a petroleum motor of 5-H.P., which can be started in five minutes and will last for 15 hours. A powerful search-light will throw its beams for a considerable distance. This wagon, which is comparatively speaking very light, also carries all the material and tools necessary for installing a flying ambulance as well as four iron poles provided with arc lights of 800-candle-power.—*Deutsche Heeres-Zeitung.*

ITALY.—*Artillery Courses of Instruction.*—Two of these courses of instruction will take place during the winter at the central school of firing at Nettuno for officers of horse, field, and mountain artillery; the first will extend from the 28th inst. to 30th January next, and the second from the 4th February to 9th March next. The first course will be attended by a captain from each of the 12 regiments of field artillery and from the horse artillery regiment attached to an army corps, and by 26 lieutenants; the second course by a captain from each of the 12 divisionary regiments of field artillery and of the regiment of mountain batteries, and another 26 lieutenants. These officers will be selected from among the senior ones, who have not been through an analogous course during the last three years.

Six batteries (three of 7-centimetre and three of 9-centimetre guns) will constitute a brigade, which will be at the disposal of the school during these periods of special training.

The Effective Strength of the Army on the 30th June, 1897.—According to an official report published recently by the Ministry of War, the strength of the Army at that date, including the Reserves, stood at 36,142 officers; and 3,263,297 men, divided as follows:—

Officers.—Standing Army: on Active Service 14,076, of whom 5,325 were married; *en disponibilité,* 248.—Officers of the Militia and Reserve, etc.: 21,818; making a grand total of 36,142 officers of all categories. This is a diminution of 2,697 officers as compared with the effective lists on the 30th June, 1896.

Men.—Standing Army: on Active Service, 237,660; on unlimited leave, 556,984 —Mobile Militia, 475,392.—Territorial Militia, 1,992,681.

The recruits of the class born in 1876 were called out for the cavalry, horse and field artillery (the train excepted) on the 20th November, 1896; and on the 4th, 6th, and 9th March, 1897, for the other branches of the Service. According to the law, there ought to have been incorporated 98,000 young men, but, as a matter of fact, there were only 79,011. The difference is accounted for as follows:—863 were serving in the Customs Guards at the time of their being called out; 4 777 were already with the colours; 1,206 did not present themselves, of whom 664 were without a valid excuse; while 9,473 were rejected as unfit or put off until another year.

The number of men on the recruiting lists had risen to 443,393, an increase of 39,041 over the previous year.

Modifications in the Recruiting Law.—The Minister of War has presented to Parliament certain modifications in the present recruiting regulations, of which the following is a *résumé*:—

1. Adoption of the military tax for men excused from active service in time of peace.

2. Division of the annual contingent into two categories; 1st Category to include all men liable for service, who do not possess titles to exemption from active service in time of peace. 3rd Category comprises those excused and transferred to the Territorial Militia from the summons of their class to the colours. This is moreover what has happened for several years, and it is intended to suppress the 2nd Category as it stands in the regulations.

3. Facilities are to be accorded to Italians resident abroad to regularise their position in accordance with the obligations the law lays upon them With this object they are to be divided into two groups :—1. Those who are born and are resident abroad, and those also who have gone abroad with their families to reside, before attaining the age of 15 years. 2. All other young men living abroad. The first-named will be excused from service in time of peace, and can obtain permission to pass a month at the longest in Italy on urgent business duly certified. The second class can be medically surveyed before diplomatic and consular authorities, but must serve with their class, if found medically fit

4 Release from active service conceded to missionaries living abroad, where they extend the influence of Italy, spread her language, etc

5. Relegation to the 3rd Category (excused from active service) of the natural son or eldest son of natural sons recognised by their mother only.

6. Addition of a clause to the regulations, by which State aid may be given to the necessitous families of Reservists and Territorialists It is believed that an annual sum of 150,000 francs will prove sufficient for the purpose, allowing in the principal provincial centres of 50 francs to women and 25 francs to each child, in the other communes of 40 and 20 francs respectively.— *Revue du Cercle Militaire.*

RUSSIA.—*The Recruits for 1898.*—A Ukase of the 30th May last fixed the following numbers for the recruits to be incorporated during the current year :— From the territories of the Empire subject to the general recruiting laws, 286,800 men. From the native populations of Térek, Kouban, and the Trans-Caucasus, 5,600 men. The numbers for the previous four years were as follows :—

In 1897	212,000	and 4,500
,, 1896	279,000	,, 3,400
,, 1895	274,000	,, 2,750
,, 1894	270,000	,, 2,400

The Trans-Caspian Railway.—A dispatch from the Minister of Railways, etc., dated Tashkent, the 10th June, to the Emperor, announces that the fixing of the rails is completely finished on the line between Samarcand and Andijane, and on the branch line from Tashkent. The Administration has already commenced to use the railway for the transport of troops, the first train having arrived at Tashkent on the 10th June.

Bicycles for Fortresses.—According to the *Varchavsky Dnevnik,* the Minister of War has decided, as the result of the trials made last year during the grand manœuvres, not to increase the number of bicycles in the field army. On the other hand, new bicycles will be supplied to the fortress troops, who will have to carry out trials testing their use in the defence of places. The Minister has ordered, for this purpose, from a French manufactory, fifty-six folding bicycles on the Gérard system, as modified by General Plioutsinsky, Commandant of the Fortress of Ossovets.

Thirty-seven of these bicycles will be placed at the disposal of the fortress troops of the Warsaw District, which already possesses forty-three of other systems. On the receipt of the new ones special bicycle detachments will be formed in each place. At Warsaw, Novoguéorguievsk, and Zegrjé a single detachment will be formed for the three places, which will be stationed at Warsaw during the spring. The result of the trials will determine the number of bicycles to be distributed among the fortress troops.—*Revue Militaire de l'Étranger.*

The Officers' Cavalry School.—According to the *Russki Invalid* this school has lately been re-organised. The object of the school is as follows:—1. To complete the education of cavalry officers in the most important branches of cavalry knowledge, in riding and the breaking-in of horses and to form instructors in fencing

and the use of the sword from amongst them. 2. To train Cossack officers for taking charge of a sotnia, and in the duties of a staff officer. 3. To train good riders among the men in the breaking-in of horses, and as instructors in swordsmanship. 4. To settle the regulations as to the method of teaching riding and the breaking-in of horses, to follow up and test all improvements and new ideas, to try different methods of training the men, and to keep in touch with changes in clothing, accoutrements, and arming.

The school consists of the staff and five sections (officers, men, Cossack section, school squadron, and smithy class); there also exists a non-combatant men's section, and the Nicholas School for soldiers' children. The school squadron serves for training in field and scouting duties; for trying different methods of teaching the men and breaking-in of horses, and also for experimenting with proposed changes in clothing, accoutrements, and arming.

Forty officers of the guard and line cavalry regiments, twenty-five of the guard and line Cossack regiments, and forty men attend the school each year; while officers and non-commissioned officers of the horse artillery can also be admitted.

The school opens on the 15th October, and the officers' course lasts two years, for Cossack officers 10½ months, for the men 1 year and 11 months. Among the subjects for instruction are the theory of riding, hippology, instruction in shoeing, the regulations and the history of equitation. The practical instruction comprises during the winter:—Riding upon broken-in horses, riding on remount horses, vaulting, riding without bridle or stirrup, tactical exercises, fencing, and shoeing; during the summer, riding upon broken-in and remount horses, field riding upon both kinds of horses, distance rides, stag hunting, shoeing, fencing, swimming, and finally tactical exercises in the field.—*Die Vedette.*

UNITED STATES.—*A Summary of the U. S. A. Commander-in-Chief's (Major-General Nelson A. Miles) Report on the War.* (*Communicated by Captain C. B. Levita, R.A.*)—Before proceeding to General Miles's report, it is worthy of notice that at the recent elections for Representatives in Congress the Republican Party managed to retain the control of both Houses of the next Congress, increasing the party majority in the Senate, and holding the House by a *decreased* majority. This decrease is partly due to the desire "to rebuke Algerism," as some papers term it. The criticism of the War Department has been a burning subject throughout the States since the revelations of want of organisation (in all branches of the Service), nepotism, and mismanagement have been so painfully brought to light in the war. In the elections of governors, Colonel Roosevelt, of the Rough Riders, has triumphed over the Democratic Van Wyck. Roosevelt has had much to say on the "misconduct" of Secretary (of State for War) Alger. Secretary Alger has had a considerable divergence of opinion also with General Miles, both before, during, and after the war. The quarrels of various other commanders with each other and the administration, have been well known throughout the States. Hence the report of General Miles on the military operations sets forth facts which were fairly well known before, but which had not been officially brought together. The report has been well received by the general public, and General Miles has, since his report, been the recipient of a banquet at which many prominent and leading men attended. The general impression left by the report is that the President and his Secretary of War steadily over-ruled and snubbed the General commanding, and then when blundering had got the Army at Santiago into a horrid mess, had to appeal to Miles to get them out of it. The recommendations which General Miles made, and which were ignored, were, to enlist a smaller volunteer army than was actually called for, to properly equip, supply, and train it, and *not* to put troops into Cuba until after the rainy season. Undertaking operations in the face of rains and yellow fever was the act of the civilian administration. General Miles applied for the command

of the Santiago expedition, but General Shafter was appointed to it. The latter, according to the Press, had neither the youth, health, vigour, nor knowledge requisite. When, having been too ill to visit his lines, he sustained a check, and a grave disaster was not only possible but probable, he applied for reinforcements. He proposed to retreat about five miles, but General Miles was sent to his rescue. Miles conducted the final operations with success; but there was a curious effacement of Miles as the commander, and Shafter was reputed to be still in command. It is generally stated that the President and Secretary Alger considered the General commanding as one whose opinions were not worth considering. (General R. E. Lee used to complain of civilian interference and to say that if he had only been an editor or a member of Legislature he might have had a chance of becoming a great General; but that having had experience and being in actual command was a fatal handicap.) It is quite probable that some of the General's report has not been shown to the public gaze.

The recommendations are moderate, mainly consisting of:—

1. A Standing Army of about 70,000 men (*i.e.*, 1 soldier per 1,000 of population).
2. A local force in Federal pay, and mainly officered by Americans for police and garrison duty in Cuba, Porto Rico, and such other territories as may be acquired.
3. The completion of coast defence.

He notes that Spain during the course of the war did not capture any American gun, colour, or soldier.

The report throws interesting light on incidents in the daily history of the war, as revealed in the newspapers, and should be read in conjunction with them, or the significance of much of it will be lost.

General Miles's Report is as follows:—

When war with Spain commenced the Army was not greater than 25,000 men, and the transport and stores of military requisites were quite inadequate; "in fact quite an amount of valuable transportation, including ambulances, had been disposed of within the last few years." When Congress appropriated $50,000,000 for national defence, General Miles urged the purchase of smokeless powder, quick-firers, machine guns, etc.

In April, he recommended the equipment of 50,000 volunteers and a reserve of 40,000—these with 10,000 "immunes" and the increase of Regulars authorised would have given an effective force of 162,597. This "with an auxiliary force of 50,000 natives, I considered sufficient, and deemed it of the first importance to well equip such a force rather than to partly equip a much larger number."

He wrote to Alger saying the war would be largely naval, and pointed out the danger of putting troops into Cuba at the wrong time of year. He also wrote that the volunteers should be regimentally camped until fully and properly equipped. He estimated that this would take sixty days, and that then they should join the main camps.

"Congregating tens of thousands of men, many of whom were not uniformed and scarcely any properly equipped, in great camps away from their States, rendered it difficult for them to be properly supplied with food, cooking utensils, camp equipage, blankets, tentage, medical supplies, transportation, etc., and was to a great extent the cause, in my judgment, of the debilitating effect upon the health and strength of the men, who were otherwise in good physical condition. The material necessary to clothe and equip large armies was not even manufactured at that time, and the consequent condition of the troops for weeks and months was injurious to the commands in many ways."

The general order fixing the minimum of supplies for troops due on May 16th, appears to have been delayed against his wishes until May 25th, also the allowance regulations and orders concerning the medical department so urgently needed were pigeon-holed until June 22nd.

The massing of troops at Tampa, etc., and the despatch of the Philippine expedition ("well conducted and eminently successful in every way"), the reconnaissance in Cuba by two lieutenants, and the various expeditions with arms and supplies for the Cubans are reported upon.

Next comes the locating of Cervera at Santiago, and General Shafter's selection to go there. General Miles applied for the command and got an answer that the President wanted to know how soon he could get an expeditionary force ready to go to Porto Rico without the force under General Shafter. Miles answered 10 days. The General reported many of the steamers as not being suitable—absence of depôts and facilities for handling supplies, etc., for 70,000. There was great delay in equipping the expedition, and although the rumours of Spanish men-of-war further delayed the proceeding, upon June 14th 803 officers and 14,935 men sailed for Cuba, leaving about 10,000 men behind for lack of sufficient transport. According to a despatch in the report, General Miles "suggested" that General Shafter should pay thorough attention to many details, asking questions thus :—

"Do the commanding officers know exactly where their supplies are?"

"Have commanding officers required their transport officers to make a list of the contents of each ship, when stored, the bulk of such stores, and an estimate of how many wagon-loads there are in each vessel?" etc., etc.

On June 15th General Miles was ordered to submit his plan of campaign at Washington, which was as follows: Santiago was to be captured, and then a "movement" of mounted troops (with Porto Principe as a base) and all the available force of Garcia and Gomez was to be made.

On June 26th orders were issued to organise a Porto Rico force, consisting of a division under General Brooke and such part of Shafter's command as could be spared.

Meanwhile Garcia and Miles communicated [There was much friction between Shafter and Garcia, and Garcia withdrew his forces eventually.] and Garcia accepted *General Miles's* wishes and executed them.

The following five despatches are of interest concerning the siege of Santiago :—

1. Playa del Este, July 1, 1898.—Adjutant-General's Office, United States Army, Washington, D.C. :—Siboney. Had a very heavy engagement to-day, which lasted from 8 a.m. till sundown. We have carried their outer works, and are now in possession of them. There is now about three-quarters of a mile of open country between my lines and city. By morning troops will be entrenched and considerable augmentation of force will be there. General Lawton's division and General Bates's Brigade, which have been engaged all day in carrying El Caney, which was accomplished at 4 p.m., will be in line and in front of Santiago during the night. I regret to say that our casualties will be above 400. Of these not many are killed.

   W. R. SHAFTER, Major-General.

2. Playa del Este, July 3, 1898.—(Camp near Sevilla, Cuba, 3.)—The Secretary of War, Washington :—We have the town well invested on the north and east, but with a very thin line. Upon approaching it we find it of such a character and the defences so strong it will be impossible to carry it by storm with my present force, and I am seriously considering withdrawing about five miles and taking up a new position on the high ground between the San Juan River and Siboney, with our left at Sardinero, so as to get our supplies to a large extent by means of the railroad, which we can use, having engines and cars at Siboney. Our losses up to date will aggregate a thousand, but list has not yet been made; but little sickness outside of exhaustion from intense heat and exertion of the battle of the day

before yesterday and the almost constant fire which is kept up on the trenches. Wagon road to the rear is kept up with some difficulty on account of rains, but I will be able to use it for the present. General Wheeler is seriously ill, and will probably have to go to the rear to-day. General Young also very ill, confined to his bed. General Hawkins slightly wounded in foot. During sortie enemy made last night, which was handsomely repulsed, the behaviour of the regular troops was magnificent. I am urging Admiral Sampson to attempt to force the entrance of the harbour, and will have a consultation with him this morning. He is coming to the front to see me. I have been unable to be out during the heat of the day for four days, but am retaining the command. General Garcia reported he holds the railroad from Santiago to San Luis, and has burned a bridge and removed some rails; also that of General Pando has arrived at Palma, and that the French consul, with about four hundred French citizens, came into his lines yesterday from Santiago. Have directed him to treat them with every courtesy possible.

11.44 a.m. SHAFTER, Major-General.

3. Headquarters of the Army, Washington, D. C., July 3, 1898.—General Shafter, Playa del Este, Cuba:—Accept my hearty congratulations on the record made of magnificent fortitude, gallantry, and sacrifice displayed in the desperate fighting of the troops before Santiago. I realised the hardships, difficulties, and sufferings, and am proud that amid those terrible scenes the troops illustrated such fearless and patriotic devotion to the welfare of our common country and flag. Whatever the results to follow their unsurpassed deeds of valor, the past is already a gratifying chapter of history. I expect to be with you within one week with strong reinforcements.

MILES, Major-General Commanding.

4. Headquarters Fifth Army Corps, near Santiago, Playa, July 4, 1898.—Major-General Nelson A. Miles, commanding the Army of the United States, Washington:—I thank you in the name of the gallant men I have the honor to command for the splendid tribute of praise which you have accorded them. They bore themselves as American soldiers always have. Your telegram will be published at the head of the regiments in the morning. I feel that I am master of the situation and can hold the enemy for any length of time. I am delighted to know that you are coming, that you may see for yourself the obstacles which this army had to overcome. My only regret is the great number of gallant souls who have given their lives for our country's cause.

SHAFTER.

5. Headquarters Fifth Army Corps, camp near San Juan River, *vid* Haiti, Playa del Este, July 4, 1898.—Adjutant-General, Washington:—If Sampson will force an entrance with all his fleet to the upper bay of Santiago we can take the place within a few hours. Under these conditions I believe the town will surrender. If the army is to take the place I want 15,000 troops speedily, and it is not certain that they can be landed, as it is getting stormy. Sure and speedy way is through the bay. Am now in a position to do my part.

SHAFTER, Major-General.

After receipt of these despatches and sensational newspaper statements it was decided that General Miles should start immediately with reinforcements, and he arranged with Admiral Sampson to conduct a flank movement under cover of the

fleet to the West of Santiago. Then General Miles rode to Shafter's headquarters, notified General Torral of the arrival of reinforcements and asked for a meeting. General Torral fixed a meeting for the next day. "That evening I became apprised of the fact that negotiations regarding the surrender had been pending between the commanding general (Shafter) and the Spanish commander, but no definite conclusion had been reached."

There is a despatch from Secretary Alger empowering General Miles to accept surrender, to order or countermand orders for an assault. The report gives weight to the fact that the Spaniards' knowledge, that Admiral Sampson took up a position to cover the landing of troops for contemplated flank attack by the reinforcements, caused the surrender.

There is then a despatch in which General Shafter says "I was told by the Secretary that you were not to supersede me in command here," and one in which General Miles says "the order of the Secretary of War of July 13th left the matter to my discretion."

He reports on his orders for "yellow" fever camps and gives Alger's despatch: "As soon as matters are settled at Santiago I think you had better return and go direct with the expedition (Porto Rico). Yellow fever breaking out in camp at Santiago will, I fear, deprive you of the use of our forces there; however, can be determined later. As soon as Santiago falls, the troops must all be put in camp as comfortable as they can be made and remain, I suppose, until the fever has had its run. It is the most difficult problem to solve. . . . . ."

General Miles reports on the successful Porto Rico expedition and eulogises the American troops engaged throughout the war:—"Under all circumstances, and in spite of many most trying difficulties, the troops have maintained the fortitude of the American character and the honor of their arms." Approximately 52,000 men were landed on foreign soil.

NAVAL AND MILITARY CALENDAR.

NOVEMBER, 1898.

1st (Tu.) H.M.S. "Edgar" commissioned at Devonport.
3rd (Th.) French Government ordered the evacuation of Fashoda by the Marchand Mission.
,, ,, Launch of torpedo-aviso "La Hire" at Cherbourg for the French Navy.
4th (F.) Major-General Lord Kitchener presented with the Freedom of the City of London, and a Sword of Honour.
,, ,, International flags hoisted over the forts and public offices in Crete.
8th (Tu.) Launch of first-class battle-ship "Oslyabya" from New Admiralty Yard, St. Petersburg.
10th (Th.) H.M.S. "Brisk" commissioned at Chatham for China.
11th (F.) News received of the defeat of the natives in the Assaba Hinterland, British West Africa, by the Niger Company's forces.
12th (Sat.) Evacuation of Crete by the Turkish troops completed.
,, ,, Morgati's stronghold captured by the Boer forces under General Joubert.
,, ,, H.M.S. "Edgar" sailed for China with reliefs.
13th (S.) Major Marchand and Captain Baratier left Cairo for Fashoda to carry out the evacuation.
15th (Tu.) Launch of torpedo-boat destroyer "Ikadsuchi" from Messrs. Yarrow's Works for Japanese Government.
16th (W.) Launch of torpedo-boat destroyer "Murakusmo" from Thornycroft's Yard for Japanese Government.

17th (Th.) Launch of first-class battle-ship "Formidable" at Portsmouth.
" " H.M.S. "Astræa" and "Forte" arrived at Plymouth from Mediterranean.
18th (F.) Issue of Special Army Order, No. 161, forming a Special Service Section of the Militia.
" " H.M.S. "Devastation" left Plymouth for Gibraltar.
" " H.M.S. "Blake" arrived at Plymouth.
" " H.M.S. "Partridge" paid off at Devonport.
19th (Sat.) H.M.S. "Cordelia" arrived at Portsmouth from North America.
25th (F.) H.M.S. "Blenheim" (relieved crew of "Barfleur" from China) paid off at Chatham.
26th (Sat.) Launch at San Francisco of first-class battle-ship "Wisconsin" for U.S. Navy.
" " Launch of H.M.S. "Bramble" from Messrs. Potter's Yard at Liverpool.
" " News received that the Mad Mullah had crossed the Swat river, and that fighting had commenced.
27th (S.) United States War Secretary recommended to Congress an increase of the Army to 100,000.
29th (Tu.) 7th Hussars arrived at Southampton from South Africa in the "Simla."
" " H.M.S. "Buzzard" commissioned at Chatham for North America.
30th (W.) 34th Company, Southern Division, R.A., left Portsmouth for Ceylon.
" " H.M.S. "Brisk" sailed for China.
" " H.M.S. "Scout" arrived at Portsmouth from the Mediterranean.

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NAVAL.

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NOTICES OF BOOKS.

China in Transformation. By A. R. COLQUHOUN. Harper Brothers. Price 16s.

This latest contribution to the literature of the Far-Eastern Question is in every respect an important production. Its author has enjoyed exceptional opportunities for studying his subject, and is credited with an intimate acquaintance with Chinese character, which has stood him in good stead in the preparation of the work under notice. To the patriotic Englishman, however, "China in Transformation" does not afford particularly pleasant reading, revealing as it does a continuity of weak and purposeless policy on the part of the British Government in respect to Chinese questions which reflects anything but credit on this country. The political portion of the book may be said to consist of a sweeping indictment against our policy in China, and it is to be admitted with regret, that the author's conclusions are fully supported by the evidence he is able to adduce.

The greater portion of this volume is devoted to an examination of the aims of Great Britain in the Far East, together with an explanation of the methods followed for their attainment; and it is plainly shown that we are the only country which has done nothing to further our interests in the Celestial Empire. Russia has annexed territory, fortified towns, and constructed railways. France has lost no opportunity of enlarging her sphere of action at the cost of the middle kingdom, and is to-day straining every nerve in her endeavours to head us off in the valley of the Yang-tse-Kiang; Germany systematically exploits the territory she has so recently absorbed; while Great Britain does nothing except make occasional demonstrations which lead to nothing except a few concessions which are certain to be contested later on, and which are not worth the paper on which they are written. In respect to the Yang-tse Valley, Mr. Colquhoun urges that that sphere must be forthwith occupied by Great Britain, unless she desires to see it handed over to Russia or to France, notwithstanding the pledge extracted from the Tsung-li-Yamen at the beginning of the present year. Above all in importance, our author urges the necessity of our securing a backdoor into China by means of the much discussed railway from Burma into Yunnan, which has been allowed to hang fire for so many years.

A very interesting parallel is drawn by Mr. Colquhoun between Great Britain and Russia as Asiatic Powers:—

> That Great Britain is an Asiatic Power is a truism. But how little realised by our countrymen! England's Asiatic dominions and dependencies cover more than 1,600,000 square miles. She has nearly 300,000,000 of souls under her rule . . . . . She has 21,000 miles of railway, and 47,000 miles of telegraphs on land in Asia, and some 20,000 miles of submarine cable. She has invested in her territories over £250,000,000 besides scores of millions invested in private enterprise . . . . . The foreign trade of these territories is more than £160,000,000 annually. The trade of the other Asiatic countries with Europe is over £60,000,000, of which four-fifths is English, while the enormous coasting trade, growing yearly with giant strides, is mainly in our hands. The British share in China's foreign trade is above 80 per cent., or more than £32,000,000 per annum. While British trade with the Straits Settlements, Siam, China, Corea, the Philippines, Japan, and Hong-Kong combined, exceeds £130,000,000 per annum. These facts should be inscribed on the walls of every schoolroom and every politician's study throughout the country.

Russia, on the other hand, while possessing four times as much Asiatic territory as Great Britain, has not got one-thirteenth of her Asiatic population. Her trade is, in comparison with our own, infinitesimal, consisting mainly of tea, which is exchanged for paraffin. But Russia obeys a law of onward and seaward gravitation accelerated by the ambitions of her statesmen and officials, and resulting in a

course of development which means progress until it encounters the opposition of a nation stronger and better than herself. To quote Mr. Colquhoun:—

> The onward march of Russia cannot be stopped even by her own rulers, unless it encounters a solid barrier, which the unchecked advance of that Power seems certain to confer on her the mastery of the world. . . . . Russia will move forward until she encounters, in place of a soft organism, a hard one. . . . which should be England.

This opinion while exceedingly apt, is of course not entirely new. It was, if we are not mistaken, advanced by Sir D. Mackenzie Wallace so far back as 1876; who wrote, when dealing with the question of British and Russian interests in Asia, "When they meet depends on ourselves. If we do not wish our rival to overstep a certain line, we must ourselves advance to that line."

In the chapter on "England's Objective" our author tells us how he would cope with the detrimental causes which are at work to-day against the interests of Britain in the Far East. He urges, above all, the improvement of communications by railways and steam communications. Burma should be connected with Yunnan, Yunnan with Hanning, and Canton with Kowloon. All these lines are spoken of as being under consideration, but the undertakings hang fire, and to-day it is known that a line between Yunnan and Hanning is being surveyed by the French!

Quite as important as the political questions in China, is that of commercial amenities; and who with any right understanding of the subject will be found to gainsay the views advanced on it in the work under review? After pointing out how the lack of Government enterprise tends to the disadvantage of the British trader, Mr. Colquhoun proceeds to administer a little lecture to the merchant on his own short-comings. The lukewarm policy of this country in China is of course responsible for much. The spirit of indifference which prompts responsible ministers to throw cold water on greatly needed schemes of railway enterprise, on the ground that such things have never been undertaken by the Government before (which is of course untrue), seems to discourage the British merchant and causes him to restrict his energies just as his Russian, French, and German rivals backed up by their Governments, and sensible that the least ill-treatment at the hands of the natives will be rigorously enquired into and punished under the supervision of a military guard, keeps forging ahead and yearly achieving a larger profit:—

> Every one who has seen anything of Western China is struck by the lack of British commercial enterprise there, as in other parts of the interior of China; but in the north-west the traders of Russian Central Asia are gradually pushing their way and establishing a firmer hold upon their markets.

On the subject of the present position in the Far East, Mr. Colquhoun brings a sweeping indictment to bear upon the results of British impotence, and the charges made lose none of their severity when viewed in connection with the fact that the writer has enjoyed exceptional opportunities for the understanding of his subject:—

> It was our duty to take China into tutelage, to strengthen her by insisting upon reforms. Instead of that, England has blindly counted on China as an ally against Russia: China, in fact, was to play the part of buffer. Our diplomacy was devoted to seeking her goodwill, even at the cost of undue deference in the questions of Sikkim, Tibet, and Burma. Slights and affronts were met with humility. . . . . After some forty years of discussion and "consideration" by our Government at home and in India, while Russia has pushed her way across 5,000 miles of Siberia, and is fast closing on China; while the Russians with audacious courage have made progress which must compel the admiration of the world, we have been supine; and China to-day leans on Russia—not on Great Britain, which she was for years anxious to do.

The fact is undeniable. It stands a reproach to our politicians that Russia is the protector of China, and Britain has to own that her policy has been a failure throughout. Nor is it difficult to understand why this is so. We have neither

trustworthy information nor governmental ability at our disposal. Our departments are ill-informed. We stand a great Asiatic Power without an Asiatic Office, a ruler of nations without a real intelligence bureau. We have, moreover, been found out, and other countries have come to realise that British Governments are seldom strong, rarely firm or consistent, and always ready to sacrifice a scapegoat.

And the remedy? It is necessary that the actual position of affairs should be faced, and that intelligent action should take the place of mere officialism. Commercial interests cannot stand alone. They must be closely supported by naval and military effort. We must take a lesson from our rivals, and deal with Asiatics on Asiatic lines. When Russia meets Chinese, craft is encountered with craft, politeness with politeness, patience with patience. And when the Chinaman meets an Englishman he instinctively recoils from the blunt, straightforward, up-and-down manner of his methods.

Mr. Colquhoun has throughout the 380 pages of this book written with a purpose, and he has written well. The complicated questions of policy and economics, inseparable from any consideration of affairs in China, are effectively discussed, and in his efforts to make plain an absorbing topic the author has been ably seconded by the publisher, who deserves all praise both for the effective appearance of the book and the excellence of the maps with which it is provided.

Die Zahl im Kriege. Statische Daten aus der neueren Kriegsgeschichte in graphischer Darstellung. By Otto Berndt, K. u. K. Hauptmann im Generalstabs-Corps. 8vo. London, 1898.

This book is an indispensable work of reference for every fighting-man and civilian who busies himself either with details of organisation and armaments, or with the broader questions which underlie the maintenance of our position against the growing competition of neighbouring nations. In a series of statistical diagrams, the result of the military and naval operations of the last 150 years are presented to us, and the conclusions to which they point are as clear and luminous as they are important. Briefly, they entirely upset every existing theory held by our statesmen, our clergy, and the press.

The progress of scientific invention is not making war more bloody. On the contrary, it is having a precisely opposite effect, and existing causes need only be allowed to develop their inevitable consequences to render an appeal to arms very materially less serious in its results to human life than it has ever been in the past, whereas disarmament and the cessation of competition in the field of invention would infallibly lead to a directly opposite result.

This conclusion is arrived at perfectly simply and logically.

Every improvement in the range of projectile weapons increases the distance which separates the two bodies of combatants at the moment of decision. The beaten force therefore gets the longer start, and already that start is so long that it is almost beyond the physical endurance of the victors to overtake, stick to, and destroy the fugitives. In the old days, as still in cavalry combats, when the mêlée once began to sag backwards, pursuer and pursued started practically with equal wind, endurance, and strength, with results similar to those with which Isandwala, El Teb, and Tamai have familiarised us so very recently. Moreover, every increment in range increases the duration of the strain on the nerves, and defeat is more and more a consequence of mental, not physical, exhaustion. Finally, every increment of range increases the need of greater numbers on the battle-field to guard against the danger of enveloping fire, and as the need for number increases, the courage of the mass very rapidly declines, for the heroes are very markedly a minority in any nation.

Conscription—that grossly abused and much misunderstood conception of Jourdan's in 1793—tends very strongly in the same direction as increased scientific invention, as the tables before us conclusively show. It proved in the most incon-

trovertible manner that "God was generally on the side of the big battalion," to use Napoleon's cynical remark, and the chief result of the series of campaigns from 1792 to 1815 was to compel every Continental nation to adopt it in some form. This brought home to each individual, in a manner which appealed to them, the realities of warfare, and forced thousands of minds to occupy themselves with military invention, which had, as a consequence, increased range and potential deadliness of weapons everywhere. And now the two factors, conscription and invention, can be seen working together hand in hand. We all know that the professional soldier, almost in proportion to his war experience, has always obstructed invention, for his experience and common sense generally taught him that it was not the guns but the men that stood behind them that decided; but the civilian in military uniform looked at things differently, and to him it was the unknown terror of the arm, especially when he was to be the target, that primarily appealed.

It was the recollections and exhaustion of the Napoleonic wars which kept the peace of Europe up to 1850, and by that time the veteran soldier class had very largely disappeared. Then a fresh twenty years of warlike activity under conditions not only rapidly changing in themselves, but complicated by new factors, the action of which had escaped the analysis of military historians, threw all military thought into a welter of confusion and gave the civilians their opportunity.

They reasoned: the guns now shoot ten times as far and ten times as fast, *ergo*, they will kill a hundredfold more, and the terror this thought awoke within them has undeniably been the chief cause of the long period of peace the Continent as a whole has enjoyed. The whole truth is that military training has made the idea of war unpopular to voters in every community, and a warlike policy is only now advocated by the scribblers in the Press who will not have to do the fighting.

Now referring again to the earlier tables in this little work, it will be seen that the breaking point in the resistance of any given body of men depends entirely on the percentage of war-seasoned veterans (not long-service peace-trained troops) the ranks may contain, and since the fear of the untried scientific inventions has kept the nations from each other's throats, till there are no longer any war-seasoned veterans in any field army on the Continent, it follows as certainly as night follows day that the breaking point will be reached in any future battle sooner than it was in the past, and then, since pursuit is now more difficult and nervous exhaustion[1] greater, the slaughter of the defeated side will be markedly less than in the past.

We have not alluded to the financial aspect of the matter, since our author also has unfortunately not investigated this side of the question. But briefly it may be pointed out that this too has tended to check the desire for war in the responsible governing classes. It is, however, curious to note how differently the various races bear their burdens and how markedly the principle of the survival of the fittest asserts itself. Whilst the Latin races are sinking under what to them is an insupportable burden, the Teutons are every day growing stronger in credit and in commercial activity, and every year the hardy educated men the German Army will turn out are pressing us closer in every market and rendering it more and more difficult for us to hold our own.

If Germany should ever command the sea? But others may answer that question for themselves.

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[1] I have used the expression "nervous exhaustion" not strictly in the medical sense, but to avoid the less understood term "psychic," which suggests to too many the jargon of Theosophy. I wish to characterise that collapse of will-power which ends in panic, terror, and lends wings to flight. It is a well-attested fact that a routed body of men will outrun any body of pursuers, throwing away arms, clothes, necessaries, even paper-money, to accelerate their retreat.—REVIEWER.

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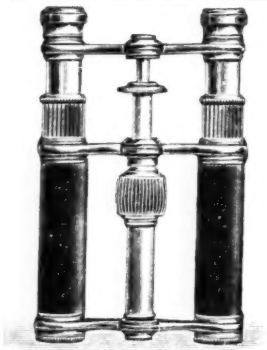

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